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BISKRA.

By Our Paris Correspondent.

Biskra, the "Queen of the Oases," lies not far from the northeastern edge of the Sahara. The desert is here sharply marked off from the northern plateau region by a spur of the Aures Mountains, through which the railroad passes by the picturesque gorges of the El Kantara, and terminates at Biskra at a distance of thirty miles. Seen from the heights of the Col de Sfa, the panorama of the desert is an impressive sight. Biskra, lying in the center of 150,000 palm trees, is the capital of the Ziban, or northeastern oasis region, and is an important date market. It was known to the Romans as Ad Piscinum, and, after passing through many vicissitudes, was conquered from the Turks by the French army in 1844. On one side of the oasis lies the oued Biskra, which in summer has the appearance of a dry river bed many hundred feet wide, but is swollen to a torrent in winter. The water supply, upon which depends the life of the oasis, is held by a dam above the town, from which lead the main canal and its branches. The town of Biskra has two distinct parts, the European quarter, which is in fact quite oriental in character, and the native quarter, an assemblage of curious adobe villages. In the former is the Fort St. Germain, which replaces the old Turkish fort, and commands the main irrigation canal. By cutting off the water supply at this point the oasis would soon dry up and form part of the desert. The beautiful gardens in the center of the town are kept green and flourishing by the water streams, and are surrounded by buildings of whitewashed adobe, whose arcades span the pavements. The same type of building may be observed to the left of the engraving, which shows the market place—one of the picturesque sights of the town. The covered building to the left stands in the center of an immense court surrounded on all sides by the arcades. In the background is the minaret of an old mosque. The market-place presents a constantly varying picture. In the outer court are strings of camels from the different oases bringing supplies of dates and other products. Here are sold olive oil from Kabylia; salt and tar, the latter being used for anointing the camels. On the other side is the stock market, with herds of camels, native donkeys, sheep and goats. In the interior the Mzabi butchers sell beef, mutton and camel's meat, and another part is brilliant with embroidered leather work, sandals, tobacco-pouches, Touareg leather cushions and Arab fans. Under the arcades are the native cafés and small shops where are sold tissues and articles of clothing, burnous, camel's-hair sacks for dates or grain, Kabyl knives and trinkets. The market is thronged with an ever-shifting crowd of Arabs, negroes and natives of the different Sahara tribes. Leading from the market-place are the streets lined with native cafés, celebrated for the dancing girls of the Ouled-Naïl tribe, from a distant part of the Sahara. These women have straight and well-formed features, like most of the Bedouin tribes, and many of them are remarkably pretty. They wear a peculiar head-dress, and the hair is formed into heavy braids, often lengthened out with black or red wool threads. The heavy silver bracelets and anklets form an essential part of their toilet, and constitute part of their dowry. Strange to say, these women are said to return to their tribes and form exemplary wives and mothers.

WELL AT BISKRA.

The native quarter, situated about a mile off, is made up of a number of villages. Viewed from one of the minarets, it appears as an immense forest of waving palms. The trees are planted in gardens surrounded by a high wall of adobe, and below them grow the olive trees, vegetables and a small crop of cereals. The system of irrigation, which is so essential for the life of all this vegetation, is very extensive and has been carefully studied out. It has been considerably increased since the French occupation. From one of the leading main canals, such as is seen in the engraving, is tapped off a small branch leading into each garden. The water

THE ARABIAN MARKET, BISKRA.

supply is regulated by a unit called the louksa, which represents a stream the size of the closed fist, and for this a fixed rate is paid by the month or year. The houses are built of adobe, and are of a very primitive character. They follow in general the type of oriental dwelling house. There are no windows in the outer wall, but in some cases a series of triangular ventilating holes is pierced at the height of the ceiling. The houses are usually built around an open court in the center, and the larger ones have a second story, or rather terrace, protected from the street by the outer wall. The door leads into a small vestibule with a divan formed of an earthen seat covered with matting. Then come the apartments of the family, consisting of an inner court, partly roofed over at the side by a palm-thatch, with pillars formed of palm trunks, or by the terrace of the second story. On another side are the kitchen and sleeping apartments, all of the most primitive construction, with earthen floors. In the court may be seen the women weaving the garments of the family upon the native looms, or grinding the meal in hand-mills.

Biskra is one of the great centers of date production, besides being the principal date market of the Sahara region. A good palm tree yields on an average 120 pounds of dates yearly, and an acre of palms produces as much as 3,000 pounds. Each tree is taxed by the government. The palms commence to flower in the early part of the year, and at that time the trees are cleaned and the dead wood and débris removed. When the flowers have matured, in the month of March, they are subjected to an artificial fecundation by applying the male flower. The fruit ripens in the latter part of October or early in November, and the date harvest is a period of great activity on the part of the natives. The bunches of fruit are cut down and stacked in the storehouses. Then follow the operations of packing and loading upon camels for transportation. Although there are many varieties of dates, they are generally divided into two classes. The soft and glutinous fruit is the best, and is the kind generally exported for European trade. The hard and dry kind is the cheapest, and is produced by nine-tenths of the trees.

EARTH-CARVING.*

AMONG the subaerial geologic agencies, none is more important than the atmosphere: the destructive effects of rain, wind, frost and the like attacks the rocks and destroy them both mechanically and chemically. The mechanical agents are, first and most important, rain itself; then frost, then the wind, then changing temperature. Of all mechanical agents nothing is so important as the rain, by which the hardest rocks are slowly but surely disintegrated, chemically and mechanically, and thus the country is gradually worn down.

While the work of the atmosphere is not so striking as that of rivers it is infinitely more important. While rivers are confined to their channel and the sea to its coast line, the atmosphere on the other hand is universal: every particle of dry land is exposed to it and nothing can escape it. These destructive activities have the general effect of wearing the land down, destroying it, breaking up the hard rocks chemically into soft soil and then sweeping them away into the river to be carried thence into the sea.

While the effect of all these agencies ceaselessly at work is thus to wear down the land to sea level or very near it, the very first effect is not to produce a general uniformity, but relief or differences of level; and this because certain parts of the rocks of a newly unheaved land are removed more rapidly than others.

Look at an old brick sidewalk, worn down until the bricks are not more than a half inch thick. They are uneven. If you examine these bricks you will see that one will be an inch and a half thick, alongside of it another only one fourth inch thick; and this because the steady wear of so many feet over it has removed the soft parts first and thus made the brick surface uneven. That is just what happens with the land when the atmosphere gets at it. There are certain parts which are removed more rapidly than others. This rapidity of removal is due to the fact that along these particular lines the rock is more easily destructible; or because along these particular lines the agencies concentrate. The first effect of these agencies is this: relief or inequality of surface.

The work of these agents varies very much in different regions. There is a climatic difference everywhere to be observed. In regions where there is an abundant rainfall and a mild climate rain is the most important agent in the destruction and removal of rock; but we have over the surface of the earth great areas of country where there is no rain, or practically none. There is really hardly any absolutely rainless country on the face of the earth; but there are plenty of desert regions where it does not rain sometimes for three of four years; then there will be a heavy shower, and that will be the last of it for years again. Material is being disintegrated and destroyed here and removed—transported; for all the agents that do this work (and do it very slowly) are agents which in the countries of moderate rainfall play a very subordinate part. These are, first, the action of the wind, which by driving sand and gravel along the surface of the ground continually wears away the rocks.

In the deserts of Arizona the hard, black basaltic rocks are channeled and polished by the action of the sand, just as if they had been in the hands of the lapidary. One of these pebbles is gouged out with its soft matrix while the harder parts are standing in relief, thus giving you the general effect of the destructive agencies which are working upon the land.

In Wyoming, five and six thousand feet above sea level, I have seen the temperature of the ground raised to 140 deg. in the sun: the rocks get so hot you can't touch them without getting your fingers blistered. This heating of the rock means the expansion of it. At night, when the sun sets, the temperature immediately begins to fall. Sometimes there will be 30 to 40 deg. difference; after sunset (or 10 o'clock) it will be freezing, when it was 85 to 90 deg. before sunset. The outside layers, which are chilled immediately, commence to contract; the outside contracts against an unyielding, hot inside and splits off; and thus there is in all desert regions a continual bombardment among the hills and cañons of falling blocks produced by this surface contraction of the rocks upon the still heated and expanded interior.

The wind blows steadily for weeks in one direction. Hundreds of miles may take them in one direction into the sea; as the Atlantic, off the west coast of Africa, is often loaded down with sand blown from the Sahara. Then, again, this wind may transport these particles of sand and gravel to rivers, and these in turn get carried off to sea; so even in desert regions we find the work of disintegration and destruction going on in spite of the practical absence of the rain.

The work of these temperature changes is not only to break off the rocks in big pieces; it breaks them up much finer than that. Almost all rocks—at least, the great majority of them—are not made up of a single mineral, but of a great many different kinds. In a piece of granite, while three minerals make the bulk of it, you will find eight or ten all told. Every one of these different minerals has a different rate of expansion and contraction when heated and cooled. These different kinds of minerals press together and pull away from one another according as they are heated or chilled, and the different parts gradually work themselves loose; and thus you may start with a cliff of the hardest granite and the result of these continual temperature changes will eventually crumble it down to a sand (undecomposed) by the mere strain and stress set up in the interior of this mass by the action of the continually contracting and expanding minerals.

Frost does just the same kind of thing, only much more evenly, in moist regions. All rocks are made up of blocks. In moist regions, where there is a moderate rainfall, these crevices or joints between the blocks get filled with water. In all countries with cold winters and in all high mountains, as this water freezes, it pries the blocks out with irresistible power. Freezing water is one of the most irresistible agents; within its own narrow limits it is as violently destructive as dynamite. Take a 10-inch shell of chilled steel and fill it with water and the ice will break that shell as if it were an eggshell. Every cliff and every exposed mass of rock in every cold country is being broken up as the ordinary changes of the air are doing in a desert without the help of water at all. In this way the whole mass of rock is gradually being worn down. The first effect is to wear it out along certain lines: to give us, at a certain stage of maturity of topography, the extreme of relief or difference of level or elevation.

A view of the mountain on the New Jersey side at the Delaware Water Gap, showing slight dislocation or faults, discloses a region of gently folded rocks which in the mouth of the gorge are tilted up at an angle of 48 deg. There we have the narrow river valley given by the hard, resistant rocks. Another view of the Water Gap from several miles below (about Manunka Chunk) shows very prettily the character of the ridge cut through by the Gap. While the Water Gap is very precipitous on the Pennsylvania side it has been planed down by atmospheric work a good deal on the Jersey side. Nevertheless, this valley is narrow; while there is a tremendous wide, open valley in the Delaware below the Gap, its width being due to the Hudson River silts which constitute the rock formation there, and which are easily disintegrated. The bold crest is due to the outcropping ridge of Oneida sandstone and some conglomerates which have resisted the action of floods and glaciers.

In the long, level sky-line of the Pocono Plateau the hard rocks come to the surface and define the character and elevation of that country.

Blockade Mountain, on the Jersey side in the Delaware Water Gap vicinity, forces the river to make a great curve, and by sweeping around in an S shape it has cut its way out.

The different characteristics of the river valley are determined by the nature of the rocks—a trench-like gorge wherever the rocks are hard and resistant; a broadly open valley wherever the atmosphere is enabled to remove the rocks.

Indian Ladder is formed by an outcropping ledge of Medina sandstone and Oneida conglomerate which constitute the Kittatinny Ridge; and here is the crest of the ridge on the Jersey side. Here is a wonderful mass of talus—frost-formed débris—certainly 800 feet deep and probably a quarter mile, if not more, along the base—all frost-made rubbish brought down from the cliff. Of course, under this action the cliff is retreating. Because of its immense resistance chemically, the rain has very little effect upon it; but the frost is too much for it.

In this view in Maine, on the Pemigewasset, observe the great boulders and the underlying bedrock. Great glacial boulders have often traveled many hundreds of miles. We find New Hampshire granite over in Long Island in great boulders, and Lake Superior copper in Indiana, carried down by the glaciers.

Here is a bit of glaciated rock, with parallel grooves made by the pebbles. As long as they are held firmly in position, they are kept perfectly parallel, as if ruled. There is just one thing will do that on any large scale: that is glacial ice. Coast ice does it sometimes, but only over a very narrow belt.

Mount Monadnock, in New Hampshire, is a great mountain which was actually overwhelmed in the ice in glacial times; and its granite sides are polished and scored by the ice. Many thousands of years ago these great ice sheets disappeared in New England; and the atmospheric weathering has removed a good many traces of the glaciers. It is only on the harder rocks it has been preserved, and even in many of them it is beginning to get dim; but here you can see the smooth, rounded, polished outline of these rocks—no crag anywhere—everything with curving contour, very different from the craggy look of a region that has not been glaciated.

At Amherst, Mass., is a glacial boulder weighing a good many tons. It could not well be carried by water under any conditions; but a great stream of ice would take it there with just as much ease as if it were a grain of sand.

Here is a glacial valley in the Rocky Mountains: a valley originally carved out by a stream, then occupied by a glacier; and you can see what a broad, flat bottom it has, such as a stream never gives to its valleys. It has the typical glacial U shape; but it is a long time since the glacier deserted it.

This view depicts a curious kind of weathering on the Union Pacific Railroad—not glacial, but atmospheric; in fact, some desert country not far from Sherman—and the work of the frost and the rain, and, still more, of the changes of temperature which are very extreme here, and the driven sand, have disintegrated this rock all to pieces, smashing it up.

The talus, or rock débris, on certain mountain slopes thousands of feet in height, consists of great blocks traveling down into the valleys; so that this whole mass of material is in slow but steady, ceaseless movement toward the sea. The relief is not by any means altogether, or even principally, the work of erosion: it is largely the work of mountain building, which enters an entirely different category.

The Bad Lands of South Dakota present mountains scored by the rains 1,500 and 2,000 feet deep, there being no vegetation to protect the rocks from the action of the rain.

* From a lecture by Prof. W. B. Scott, of Princeton University, delivered at the Wagner Institute, Philadelphia. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

TESTS OF CHEMICAL MANURES IN THE EXPERIMENTAL FIELDS OF HAUTE-SAÔNE, FRANCE.

As in other departments, there exists in Haute-Saône several fields which receive supplies from the Ministry of Agriculture and from the local authorities. They are under the direction of the Departmental Professor of Agriculture.

The grants are of seeds and chemical fertilizers. The beneficiaries are charged with the work of cultivating, gathering, weighing, etc., which are prescribed by special instructions. Thus, experimental fields increase in number each year, and unquestionably exercise on cultivators a favorable influence. There is no better method for popularizing phosphates, superphosphates, and other fertilizers.

Recent results show that the increase of yield through the judicious employment of chemical fertilizers has risen in Haute-Saône to between 20 and 30 per cent.

Phosphated manures, especially the phosphatic slags and the nitrated manures, are those better suited in general to the fields of Haute Saône.

Potash salts, on the contrary, have very little efficacy. This appears from the evidence collected by the Departmental Professor of Agriculture at Vesoul.

The last experiments bore equally on the seeds usually employed in the country and those of the same kind reputed as rendering the highest yield.

They have shown, for wheat and oats, that the local varieties offer more resistance than the new kinds. The latter have not endured the inclemency of the climate so well. But it is important that the cultivators of Haute-Saône improve their own seeds by a careful selection.

The opposite result appeared in the case of potatoes. Richter's Imperator, for example, has been found superior to the old varieties, so its adoption has become general among thousands of intelligent farmers.

The results obtained in the beet-root cultivation are most encouraging. They are the more so because this culture for distilling and sugar making has not been valued highly in most of the districts of this department, and especially in the arrondissement of Vesoul and Lure.

The variety tested has been the Collect Rose.

It must be expected that this crop will be developed quite extensively in Haute Saône. Two distilleries established lately at Fougerolles and Corre can consume the whole production of the vicinity.

It is becoming evident, too, that the cultivation of the beet may become a new source of profit for the agriculture of this region.

The Departmental Professor of Vesoul sends us the following account of some of the last experiments:

"Each field has been cultivated and fertilized with the manure of the farm uniformly throughout its whole extent, according to the directions given.

"Then it has been divided into two portions: (1) a part without chemical fertilizers; (2) a part enriched with chemical manures.

"This second part has received 10 kilogrammes per acre of a fertilizer containing 2 per cent 'nitric' nitrogen; 4 per cent soluble phosphoric acid; 7.5 per cent phosphoric acid, from phosphatic slags; 3 per cent of potash in the form of a sulphate.

"The results obtained give, per hectare, the averages below:

	Francs.
"Parcel No. 1: 31,330 kilogr. of beets were sold at 17 francs per 1000 kilogr.	532.55
"Parcel No. 2: 40,647 kilogr. of beets were sold at 17 francs per 1000 kilogr.	691.10
"Difference per hectare in favor of the chemical fertilizer	158.45
"The 1000 kilogr. of chemical manures applied per hectare having cost..	110.00
"The net proceeds per hectare is 158.45—110 =	48.45

"Say 44 per cent on the capital employed, without counting the part which has not been exhausted, and which will certainly favor the 'succeeding crops.'"

These are magnificent and encouraging results. They have produced their effect. The number of beet farms is increasing, and the area now to be devoted to beets is about 300 hectares.

It may be predicted that by the selection of seed and the utilization of chemical fertilizers the cultivation of the beet will gradually extend through France and the industry in these enriching materials will also be benefited.—Translated from Le Phosphate.

UTILIZATION OF PHOSPHATIC CHALKS.

Messrs. J. Graftiau, director of the government analytical laboratory at Lourain, and F. Graftiau, agricultural engineer at Trognée, have just published the result of their researches on the gray phosphatic chalk used in the manufacture of the Thomas and Gilchrist steel. The information is timely, in view of the difference of opinion concerning the fertilizing value of the slag obtained from this process of steel production. A resumé of the work of the chemists, with their conclusion, will be of value.

The question of the utilization of the gray phosphatic chalk in the process in question is of interest to industry in general, with reference to the economical production of a steel of good quality, and to agriculture in particular, by furnishing a waste product, which is a very efficient phosphatic fertilizer. It is far from being sufficiently appreciated by cultivators at large.

The designation of the scoria in commerce as Thomas phosphatic slag, and the term phosphated slags, and that of basic phosphates, are all names for the same article.

Now, as regards the obtaining of this basic phosphate, formerly the iron ores which contain phosphorus were classed as a raw material of inferior quality, because they furnished a brittle metal. To Thomas and Gilchrist is due the honor of having, after long research, ascertained the method of eliminating the phosphorus by the Bessemer process, operating from the outset of the work in a medium sufficiently basic, secured principally by the introduction into the apparatus of calcareous and magnesian substances. But the value of the slag thus obtained, as of many another product, was yet to be demonstrated. It was only after having been regarded as a worthless and troublesome residue that agricultural science succeeded in establishing, after a series of experiments in cultivation, that the fertilizing value of this waste product had been singularly underrated, and that there had been no occasion for its useless accumulation around the steel works. As soon as this valuable quality was recognized, the consumption of the Thomas slag as a fertilizer rapidly increased, and the production was insufficient. There was a new situation to be met.

The actual part which the slag plays in agriculture may be better understood by examining the statistics concerning its manufacture and the consumption in the principle producing countries of Europe. According to M. Grandeau, the figures, representing metric tons, were in 1898 and 1899 as follows:

	Production.	Consumption.
Germany	786,000	730,000
United Kingdom	256,000	110,000
France	198,000	198,000
Belgium	112,000	80,000
Austria-Hungary	64,000	90,000
Exportation	——	208,000
Total	1,416,000	1,416,000

Belgium, in proportion to its extent, holds the first place in the production and the consumption of the Thomas phosphatic slag, a new proof of the progress of our cultivation, as compared with that of our neighbors.

On applying the process of dephosphoration, the metallurgists soon perceived that a good market required a minimum proportion of the metallic refuse mingled with phosphorus. The suitable average proportion is from 1.8 to 2.25 per cent. If the ore to be treated is sufficiently rich in phosphorus, the operation is conducted without the addition of phosphatic substances. But if not, an addition is made to meet the requirement.

It is thus that the employment of the gray phosphatic chalks, which are found in large quantity in Hainaut and the Somme, now contribute to augment the production of the slag.

For economically supplying the deficiency, a raw material must be used, low in price, poor in silica, and in a state of suitable aggregation.

The rich phosphates, which are used in the manufacture of susperphosphates, are too dear, too rich in silica, or too pulverulent, conditions not suitable for their advantageous employment. On the contrary, the gray chalk of Hainaut satisfies the needed conditions, being of low price, and composed almost exclusively of lime carbonate and phosphate. Introduced into the blast furnace, it yields its phosphorus readily. By suitable management the metallurgist can at will produce a molten mixture, more or less rich in phosphorus, designed for steel production by the Thomas and Gilchrist process. From these different considerations, it will be understood that the employment in metallurgy of poor phosphated chalks has for its object the conversion of an inert product into an abundant source of phosphoric acid easily assimilable by plants.

It remained to be proved that the scoria derived indirectly from the chalk is identical with that obtained by other methods. The researches of the Messrs. Graftiau were specially directed to this question. It results from their analyses that this phosphated residue has not only the composition of the Thomas slag properly so called, but also that its phosphoric acid acts in the same way with the reagents adopted in the laboratories to establish the degree of solubility. This seems to prove that the chemical composition is exactly the same.

Without entering into the details of the analyses, we notice the composition of two samples of slag proceeding from the dephosphoration of the melted ores with the employment of gray phosphatic chalks in the blast furnace:

	I.	II.
Total phosphoric acid (average), per cent	20.22	21.98
Phosphoric acid, soluble in the Wagner re-agent	19.46	20.86
Relative solubility in this re-agent	91.00	94.00
Free lime	9.80	3.76

These are products having high proportions of phosphoric acid, whose solubility leaves nothing to be desired, as compared with the value of the ordinary product.

If the manufacture of the Thomas slag with the aid of the gray chalk has been regarded as an operation against which the agricultural public should be warned, everything leads to the conclusion that this is an error. It is evident that the source of the phosphorus is of no consequence, so long as this element is a part of the molten material. The chemists, therefore, are justified in their conclusion:

"Instead of being an injurious adulteration, the new employment of the gray chalks is in reality a valuable advance in the utilization of the phosphatic ridges of the basin of the Mons and of the north of France."—Translated from the Independence Belge.

EXPLOSIONS OF VOLATILE VAPORS IN FACTORIES.

By H. L. Terry, F.I.C.

There was recently a serious explosion at the hat factory of Messrs. Wilson & Sons, at Denton, near Manchester, whereby fourteen persons were killed. Although discussion of affairs relating particularly to the hat trade does not come within the purview of this journal, yet there was so much identity between this catastrophe and others which have happened, and may not improbably happen again in India-rubber works, that I feel that it is not superfluous to say a few words on some of the salient points investigated at the inquest. The explosion occurred in the drying stove, where the hats, after being dipped in a solution of shellac in methylated spirit, were placed in order that the vapor might be evaporated. This operation is one that is common to the trade, and although some slight explosions have been recorded, nothing at all serious seems to have happened to demonstrate to the manufacturers the latent possibilities of disaster. In general the alcoholic vapors have been allowed to escape, through ventilators, into the atmosphere, but now in several works both in England and the United States are to be found recovery installations, the vapors being condensed for use over again. That the recovery process, when in operation, lessens any risk of explosion, the evidence which has been given by a hat manufacturer of America who has several of these recovery plants in operation tends strongly to show, but unfortunately in the case of the recent explosion, which happened on a Monday forenoon, the recovery plant was not working, a fact which undoubtedly formed a prominent factor in the situation.

The case was thoroughly investigated by the chief inspector of explosives to the Home Office, and as there were several points in his evidence at the inquest which are of technical interest, I shall proceed to touch on some of them. Commencing with a generality I quote his statement that the full extent of the danger in these stoves did not appear to have been realized by the majority of hatmakers. This is no doubt true. Probably the majority of hatmakers know little or nothing about the laws of chemical combination that operate when certain portions of oxygen or air and of volatile vapors come into contact with a flame. The reference need not be limited to hat manufacturers as far as ignorance of such scientific details goes. It may fitly be extended to many trades where volatile vapors are used in some form or other. In addition to the rubber manufacturer, with his naphtha and carbon bisulphide, there is the dry cleaner who uses benzoline instead of soap, and there are many concerns where volatile solvents are used as extractive media.

Now it goes without saying that practically all, from the master to the humblest employe, know that such solvents will take fire if brought into contact with a light, but in many cases this represents the sum total of their knowledge; the fact that a material may take fire and burn quietly when one set of conditions prevails and that the same material may explode with disastrous consequences when the conditions are altered, may be but to only a slight extent, is not one that has impressed itself at all generally upon the minds of those who hold positions of authority in works where such dangerous elements are found. Take any of these volatile solvents, naphtha, carbon bisulphide, methylated spirit, etc., and set fire to a small quantity, either in the open or in a vessel filled with them and communicating with the air by means of a tube, and what happens? A flame is produced and burns quietly. Suppose, however, we alter the conditions and shake up a small quantity of the liquid in a vessel with a definite quantity of air; on firing it either by a flame or by electric spark we get a violent explosion. The latent energy that vapors possess and which reveals itself under the condition just named is not sufficiently widely known, and I think that the government inspectors would be doing useful service if they issued information of the sort to the various factories where volatile solvents are used.

In two fatal explosions which have occurred in the dry cleaning process, the evidence went as in the present case to show a lamentable lack of knowledge on the part of the principals as to the potency of the agents they employed, and it certainly seems desirable that the workmen should not be exposed to risks by reason of the failure of their employers to recognize the possibilities of disaster. The inspector said that from the violence of the explosion it was evident that the theoretical mixture of air and alcoholic vapor must have been present, and this proportion, he went on to say, was 1 of vapor to 12 of air. Later on he says in his evidence, when discussing the details, that there was several times as much spirit as would be required to form the most explosive mixture. Now, I have had no acquaintance with the explosion of alcoholic vapors, but I cannot quite reconcile these statements to theory. To get explosion or instantaneous combustion in a limited area, the theoretical proportions of air and vapor are necessary; if one or the other is in excess, the explosion is either very feeble or does not occur at all. I know in the experiments which I have made with carbon bisulphide and naphtha that an excess of air or of vapor prevents the explosion, and the remark quoted above, that the alcoholic vapor was in excess, does not harmonize with the facts of the explosion. Of course, the excess in this case may only have been to such an extent as to modify without preventing the explosion, though this supposition hardly coincides with the statement as to the atmosphere of greatest explosibility being present. The necessary conditions for an explosion are: (1) the proper amount of air; (2) due admixture of this air with the vapor, (3) a sufficiently high temperature to set fire to it. Perhaps the best example of this is to be seen in cases of colliery explosions of marsh gas or fire damp, and at the risk of boring my readers by going too much into detail, I append the combustion equation of such an explosion:

$$CH_4 + 2(O_2) + 8(N_2) = Co_2 + 2(H_2o) + 8(N_2).$$

Here we see that complete combustion takes place, the proportion of fire damp and air by weight being 1 in 20, and by volume 1 in 10, which is the most explosive mixture. To pursue the subject further on scientific lines would require much more space than the present occasion affords, and it might, moreover, not prove of general interest. That it is of importance will, however, I think, be generally conceded, and the three conditions mentioned above should be duly noted. Referring for a moment to No. 3, the temperature of ignition will be found to vary within wide limits in the case of different vapors. For instance, marsh gas requires a flame or electric spark, and so does alcoholic vapor, while carbon bisulphide vapor, on the other hand, will ignite by a hot—not by any means a red-hot—piece of iron. The temperature required in the hat explosion is stated to be 1,200 deg. C., and therefore a light must have come into contact with the vapor, though by what agency the inquest failed to discover. There was close questioning by the coroner as to the notices against smoking, and on this point the firm were able to give satisfactory answers. Nowadays, what with employers' liability and other ropes round his neck, the manufacturer cannot take too much care to see that he safeguards his interests sufficiently, and it cannot be considered a waste of time or labor to go beyond experience and to investigate possibilities.

In a recent important trial for damage done to surrounding property by an explosion, the jury held that the nature of the chemical products should have been investigated, and although this may sound like laying down a law difficult to comply with, it is clear that if this view obtains general acceptance, those who make and those who use chemicals will not be able to shelter themselves in the future comfortably under the plea of ignorance. It is difficult to see how any manufacturer who causes an explosion by unscientific or careless handling of volatile vapors can expect to escape from the consequence thereof. Despite newspaper references to pent-up forces suddenly and mysteriously coming into action there has been nothing about the recent explosions which have taken place in England which is not immediately explainable by theory, and there can be no doubt that in the future the manufacturer will be held more responsible for pleading ignorance of this theory than has been the case in the past. Scientific matters are not, of course, immediately assimilable by those who have had no scientific training, and the fact that expert advice has been sought cannot fail to have weight in any case of disaster arising.

Lack of attention to matters of ordinary precaution, such as the posting of notices relating to lights, to smoking, etc., can easily be remedied, and the more general labeling of casks containing volatile liquids with warning notices as to lights suggests itself as desirable. A point which has sometimes given rise to trouble in rubber works is the disposal of waste bisulphide of carbon liquor. I have known of cases where this has got into drains and been fired by steam pipes, and where it has been fired on accumulating in places where the damage done was really serious. Every precaution should, therefore, be taken to see that its ultimate disposal is carried out with due prudence and foresight. A word may fitly be said with regard to the volatility of naphtha used in spreading. There is a tendency at the present day to use more volatile naphtha than was the case ten or twenty years ago, and it may be that the risk of fire or explosion in the workrooms is increased. I do not myself know that the risk is really greater than formerly, and incline to the opinion that with proper ventilation there need be no danger of explosion at all, whatever may be the case, with inflammability by electric spark. Certainly the light naphthas are now being generally used with as much immunity from disaster as before, and the point is only referred to on account of some remarks recently made to me on the subject by a rubber manufacturer. As a rule, spreading is carried on in rooms plentifully supplied with windows, and it would be difficult for the atmosphere to assume explosive proportions; where, however, the ventilation is not of the best the use of a fan or a Roots blower as an auxiliary is often advisable.

The use of naphtha recovery plant has made but little headway, though the removal and condensation of the fumes entirely prevents the dangerous accumulation of vapors. An addendum should be made to this statement in the form of a warning as to the likelihood of danger arising from a stoppage of the recovery process. A recovery plant which was generally employed in the case of the hat works was at the time of the explosion not at work, and though the process itself could not be blamed in any way directly for the catastrophe, the fact must be remembered that where recovery processes are in operation vapors accumulate rapidly. Should, then, any accident happen to the machinery and means of ventilation not be at hand the situation, of course, becomes one of peril. An instance of this is to be seen in the explosions which have occurred in uncaloring machines which have been boxed in under the new Factory Act regulations. Under the old open-air system explosions never occurred, though fires were not unknown; now, however, if the strap happens to come off the fan when work is in progress it only takes a few minutes for an explosive atmosphere to collect. It seems to be imperative, therefore, that in all recovery plants effective means of ventilation should be at hand to avert danger arising from any stoppage.—India Rubber World.

ANATOMY AND HABITS OF THE FISH.

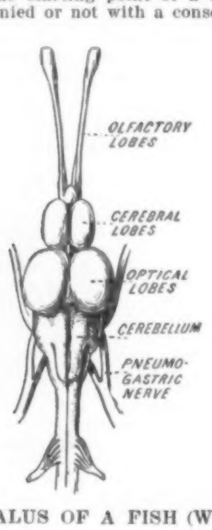
It is our purpose in this article to give a short account of the natural history of the fish, including its anatomy, habits, etc.

Excretory Apparatus.—The kidneys of the fish, which are very bulky, occupy almost the entire length of the visceral cavity and are located in the dorsal part between the spinal column and the swimming bladder. They sometimes extend in front up to the base of the cranium. From each of them starts in the rear a conduit, the urethra, that collects the excreted products, and the two conduits debouch in most cases in a urinary bladder placed almost in front of the anus and opening externally by a urinary pore which is common to it and the genital organs. One important peculiarity distinguishes the kidney of the fish from that of the other invertebrates. The urinary canaliculi, instead of terminating in *culs-de-sac* in the interior of the kidney, end at its surface and debouch in the cavity of the body through a small funnel ciliated at the circumference.

Nervous System.—From the viewpoint of the reflex nerves, fishes have nothing to envy us. In fact, their spinal marrow much resembles our own. It is a soft and whitish cord that follows the vertebral column dorsally, and gives off regularly, between the vertebræ, pairs of rachidian nerves that extend to the muscles and skin of the corresponding regions. Every nerve starts from the spinal marrow by two roots—a dorsal, through which the sensitive impressions starting from the skin reach the marrow, and a ventral, through which the nervous influx returns from the marrow to the muscles in order to give them a motor impulsion.

Fishes are not distinguished for their intelligence. They of all vertebrates are the most poorly endowed as regards the pyramidal cells that preside over the voluntary motions, and with the activity of which consciousness is connected. Their brain is but slightly complicated, and is small in proportion to their size. The cranial cavity is small, and the brain fills but a feeble part of it, surrounded as it is by a thick mass of fatty or gelatinous matter. We remark especially a feeble development of the cerebral hemispheres, which are precisely the seat of the pyramidal cells. The accompanying figures show better than a long description the constituent parts of this organ and the cephalic nerves that originate therein. These nerves extend to the organs of the senses.

The Organs of the Senses.—The sense of touch, as with us, is exercised by the entire surface of the body. A contact everywhere determines a modification in the nervous terminations of the region considered and becomes the starting point of a reflex muscular action accompanied or not with a conscious sensation.



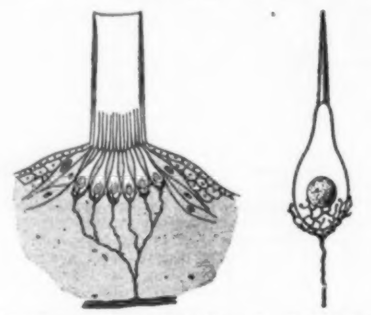
ENCEPHALUS OF A FISH (WHITING).

By reason of the scales the general sensation of touch is quite obtuse; but there are regions of the skin that are eminently sensitive and which their peculiar structure predestines in a more special manner to be affected by contacts. They are all nervous, so to speak, and ready to be influenced quite easily. Such are the wattles, which are generally inserted in the vicinity of the mouth of a large number of fishes, or the rays of the pectoral fins, which, in the gurnards, are transformed into a sort of finger.

With the tactile organs are connected those of the "lateral line." Upon the first examination of a fish we remark in the center of each of its sides a longitudinal line of which the color does not harmonize with that of the rest of the skin, or which a series of special scales sharply differentiates. This is the "lateral line." For the entire length of this are arranged small sensorial organs that receive branches of the same lateral line. Each of them is a sort of cup, a slight indentation of the skin in which are observed large cells in the form of a pear, the stem of which is a stiff hair directed toward the exterior, while the pear itself is held as if by hand in a small basket formed by the terminal arborescences of a nervous thread. These are the sensitive cells. They are protected and sustained by other cells with long cilia that surround them and sometimes form, through the coalescence of their cilia, a curious cylindrical chimney. The scales of the lateral line contain small perforations opposite these organs, so that the water moistens the stiff cilia of the pear-shaped cells. Series of analogous organs are observed upon the head, following the edge of the eye, the contours of the jaws and the operculum.

The function of these organs is not strictly tactile. They are not designed to be influenced by contact with external objects, but serve to allow the fish to perceive the disturbances of the water that surrounds it; and each of them is particularly affected by the vibrations that reach it normally. Owing to the lateral cephalic organs, which assume nearly all positions, the fish is able not only to feel a disturbance of the water, but to localize the direction of it. The rapidity with which a fish perceives the undulations produced by the fall of an object into the water, and with what precision it directs itself with respect to the point of fall, is well known. Besides, when the fish moves the undulations of its body cause a variation in the pressure of the water against its various lateral organs, and by this fact it is informed as to the variations of attitude of the parts of its body with respect to its environment. It knows, moreover, the relative positions of the parts of its body by a sort of internal touch which Father Bonnier has happily called the "sense of segmentary attitudes." By combining all this the fish has a notion of its total attitude in its environment. At the same time the lateral organs inform the fish as to the general movements of the fluid with respect to itself. It knows whether it is drifting in a current or is caught in a whirlpool, and in what direction the water is moving with respect to itself.

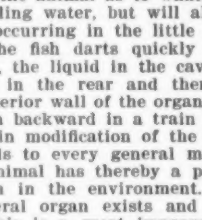
Imagine now that a lateral organ, instead of re-



A LATERAL ORGAN AND AN ENLARGED SENSORIAL CELL.

maining flush with the skin, is sunk in the depth of the tissues, and that, instead of remaining in contact with the water, it no longer touches anything except the viscid liquid secreted around it in the cavity into which it has shrunk. This organ will no longer be able to inform the animal as to what is taking place in the surrounding water, but will always inform it as to what is occurring in the little pocket. Let us suppose that the fish darts quickly forward; then, through inertia, the liquid in the cavity will remain for an instant in the rear and then be projected against the posterior wall of the organ, just as passengers are thrown backward in a train that starts suddenly. A certain modification of the sensorial organ thus corresponds to every general movement of the fish, and the animal has thereby a perception of its general position in the environment. Well, such a deep-seated lateral organ exists and forms the ear of the fish. This is a great improvement upon the primitive organ, and its complication is such that it is called the "labyrinth." It corresponds exclusively to our internal ear. Fishes have neither an external nor a middle ear.

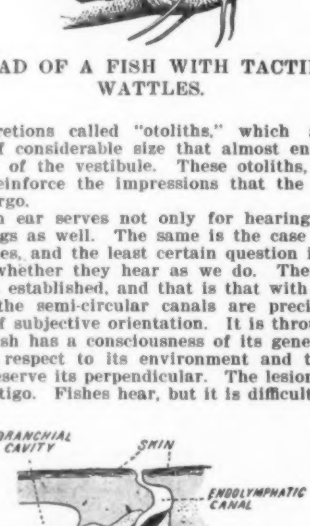
In the endolymph that fills the labyrinth float min-



HEAD OF A FISH WITH TACTILE WATTLES.

eral concretions called "otoliths," which are true ossicula of considerable size that almost entirely fill the cavity of the vestibule. These otoliths, by their contact, reinforce the impressions that the sensorial cells undergo.

Our own ear serves not only for hearing, but for other things as well. The same is the case with the ear of fishes, and the least certain question is that of knowing whether they hear as we do. There is one thing well established, and that is that with them, as with us, the semi-circular canals are precisely this function of subjective orientation. It is through them that the fish has a consciousness of its general situation with respect to its environment and that it is able to preserve its perpendicular. The lesion of them causes vertigo. Fishes hear, but it is difficult to know



EAR OF A RAY.

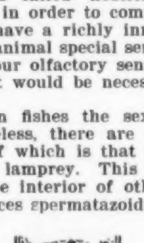
to what point they have sonorous sensations. Their ear, in fact, is destitute of a cochlea—that so wonderfully delicate organ through which we appreciate the intervals of sounds and the differences of "timbre." But, on another hand, we know that sound is transmitted much better and more quickly in water than in air. So, perhaps for fishes an organ less perfect than ours suffices. It may be said for a certainty that fishes are very sensitive to noises; but it is very likely that in sounds they distinguish differences in intensity solely. Nevertheless, harmonious sounds are known to have been produced by certain fishes owing to a vibration of the swimming bladder. Perhaps such fishes have a rudiment of the musical sense.

The ear has also, at least in certain fishes, another curious function. In the shad and herring the swimming bladder emits in front a diverticulum that extends to the cranium and expands into a vesicle in contact with the vestibule. In the perch and loach a chain of ossicula establishes a communication between the walls of the labyrinth and bladder. In both cases it seems as if the ear must inform the fish as to the tension of the air in the interior of the bladder, and consequently as to the depth at which it is situated.

The eye of fishes will not detain us long. It is constructed essentially like that of all vertebrates, and constitutes a sort of photographic camera in which are depicted the images of external bodies. The sensitized plate is the retina, which is situated at the back of the eye. Let us say only that since fishes live in water their eye is constructed like a submarine photographic apparatus, with a very convergent objective. The crystalline lense is spherical. The eyes as a general thing are large and not very movable. There are neither eyelashes nor lachrymal glands. Deep water fishes often light themselves by means of luminous apparatus constructed like electric projectors.

The tongue of fishes does not present a particularly rich innervation. It does not seem as if the sense of taste of these animals were well developed. As for the sense of smell, some authors have believed that aerial life is necessary for the exercise of this, and that fishes cannot perceive odors. Nevertheless, we see fishes attracted from a distance by baits that to us would be odorless, and it is said that the heron, in order to entice its prey, uses an odoriferous oil secreted by a cutaneous gland. Above the upper jaw fishes have cavities called nostrils, which do not traverse the palate in order to communicate with the mouth, but which have a richly innervated wall that certainly gives the animal special sensations. Wherein do these resemble our olfactory sensations? In order to be able to say it would be necessary to be both a man and a fish.

Multiplication.—In fishes the sexes are generally separate. Nevertheless, there are a few exceptions, the most curious of which is that of the myxine, or hag, an ally of the lamprey. This singular fish lives as a parasite in the interior of other fishes, and its genital gland produces spermatazoids in the first place



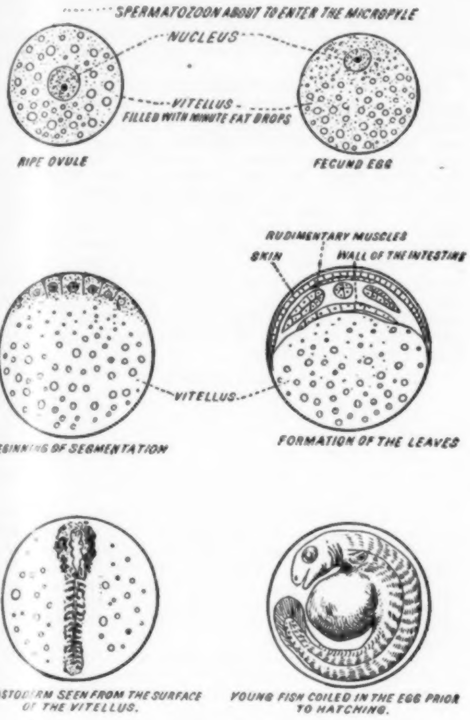
SECTION OF AN OVARY, SHOWING THE STAGES OF DEVELOPMENT.

and afterward ovules. The young myxines that are less than 13 or 14 inches long are males. The longest are females, and those of medium length exhibit all degrees of hermaphroditism.

In the majority of cases the genital organs are even in number and very simple in both sexes. The ovaries are sometimes simple folds suspended from a peritoneal thread. The ovules develop in the thickness of these folds, then emerge from their surface and finally fall into the general cavity of the body whence they make their exit through two abdominal pores situated back of the anus. Such is the case with the eel and the salmonidæ. In most cases these ovarian folds are inclosed in a sack prolonged by a canal—the oviduct, which debouches beyond the anus, at the same point as the bladder. The ovules, such as they are produced in the ovary, are enveloped in a shell containing a small orifice called a micropyle. At the moment of spawning the bulky ovaries fill a great portion of the visceral cavity and constitute what is called the "roe." They are then filled with an enormous number of ovules, which, in a carp, is estimated at 300,000, and in a 20-inch codfish at 9,000,000. The male organs are, like the ovaries, in the form of elongated sacks. At the moment of spawning they are very bulky, and, under the name of "milt," are distinguished from the roe by their whiter color and their consistence. The fecundation of the ovule is almost constantly left to chance, and there is no coupling. At the "season of love" the males pursue the females and swim about them with much ardor; but it might almost be said that sly glances suffice for their happiness and their love is platonic. The female abandons her eggs in the water and the male afterward comes and allows the contents of his milt to exude in the vicinity. The eggs are afterward left to themselves. This is a matter of great importance, since it renders artificial fecundation easy. This is the starting point of pisciculture.

In some species the eggs, instead of being left to themselves, are incubated; and, what is a curious thing, it is often the male that attends to such family cares. The male hippocampus carries the eggs in a ventral pocket. The chromid carries them in its mouth and looks after the young fry until they are capable of taking care of themselves. Certain small carp are more discreet, and, without abandoning their eggs, properly speaking, they are able at least to get rid of the tiresome care of rearing. They have, so to speak, recourse to public assistance in order to put their offspring to nurse. At the epoch of spawning a male chooses a female and carefully drives away from her all the rivals that would like to approach her. It is very probable that there is a mutual consent and that the female likewise selects her male, since the latter at the moment of mating assumes extremely bright colors and puts on a true wedding suit well calculated to captivate his companion. The latter modestly keeps on her everyday dress, but her oviduct becomes prolonged externally into a long tube that serves for oviposition. The paired fishes swim side by side in search of unios—large fresh-water mussels that live buried in mud. At length they find one. The mollusk is asleep with shell partly open and with no suspicion of the plot hatched against it. It is a ques-

tion, nevertheless, of converting it into an artificial incubator. The female approaches, measures the distance with her eyes and looks at the aperture, and then abruptly introduces her oviduct and deposits an egg in the branchia of the mussel. The male moves about overhead and does his duty, and then the couple continues its journey in search of another unio. "Poor mussels," one might exclaim; but be quiet, they have their revenge. It is necessary for the young unios, in fact, in order to develop, to live for a certain time as parasites upon fishes. When a unio abandons its progeny its young larvæ swim around



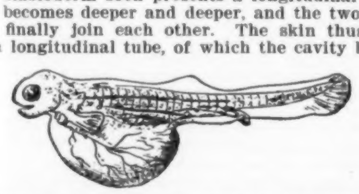
THE EGG FROM FECUNDATION TO HABITATION.

here and there until, finding a fish, they fasten themselves to its branchiæ, which in turn serve as incubators.

As a general thing an egg laid upon the bottom and secured to a plant or protected under a shell is completely abandoned to itself; and it is certainly one of the most wonderful phenomena of nature to see so complicated and perfect an organism as an adult fish formed from a little ball of jelly.

Development.—The ovule as laid is, as we have said, a cell, a sort of a drop of jelly exhibiting in its center a darker and more compact grain—the nucleus. In the jelly there float oily globules, reserve materials, that constitute the vitellus or yolk of the egg. All around is the shell of the egg. A spermatozoon enters through the micropyle and its head becomes confused with the nucleus of the ovule that has come to meet it. Here we have the intimate phenomenon of fecundation. The egg cell is formed. Embryogeny begins, as in other animals, by segmentation; that is to say, by the division of the egg cell successively into 2, 4, 8, 16, 32 or more cells, and this process continues during the entire development. At the adult state the fish will be exclusively formed of cells that will all be due to successive divisions of the initial egg cell and that will be differentiated in order to give the elements of the skin, muscles and nervous system. The first cells are connected with a pole of the egg, forming a sort of cap, the blastoderm, which gradually encroaches upon the edges and envelops the vitellus collected beneath it. The vitellus will serve to nourish the cells in course of formation, while the blastoderm will give the organs themselves. Its most external layer will give the skin and nervous system and the inner layer the digestive tube. Between the two will be formed the muscles, blood vessels, genital organs and skeletons.

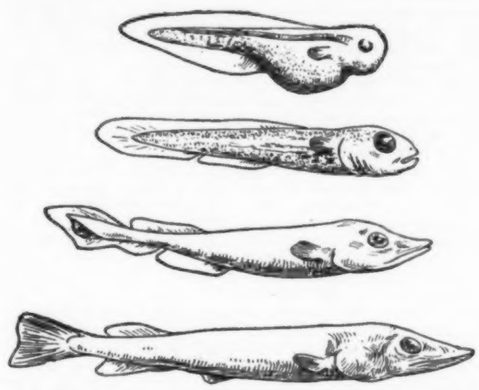
The blastoderm soon presents a longitudinal furrow which becomes deeper and deeper, and the two lips of which finally join each other. The skin thus closes upon a longitudinal tube, of which the cavity becomes



YOUNG SALMON RECENTLY HATCHED.

gradually obliterated and which becomes the central nervous system, spinal marrow and brain. Beneath this tube there forms, at the expense of the lower germinal disk, a strong longitudinal rod—the dorsal cord. Around the latter there next appear cartilaginous rings strung like the beads of a rosary and constituting the rudiments of the vertebral body. Finally the myotomes form on each side with perfect regularity. The eyes and branchial fissures soon appear and allow the rough outlines of the head at one of the extremities of the embryo to be recognized. The opposite caudal extremity elongates, and since, like the embryo, it is always inclosed in the shell of the egg, it is obliged to curve upon itself, and often makes more than one turn. Thus bent it forms a spring, through the tension of which the shell finally bursts. The young fish is thus hatched; but it is as yet only a larva, in most cases greatly differentiated from the adult by its external form as well as by its external organization, which may be seen by transparency through its delicate tissues.

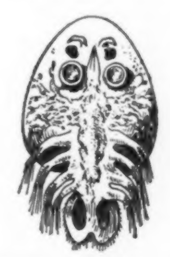
As a general thing the embryo during its development in the interior of the egg does not use up all of its vitellus. So the young larva, at its birth, carries under its belly a sack full of yolk which is so large (especially in trout and salmon) that it cannot drag it along and has to remain at anchor upon the bottom for several days without taking any nourishment. The larva could not digest prey, moreover, as



SUCCESSIVE LARVAL FORMS OF THE PIKE.

its digestive tube is not yet formed; so, like the embryo, it feeds at the expense of the vitellus, and, in measure as it develops, the sack disappears. All along the back and under the belly a fold of the skin forms a continuous primitive fin. Later on rays of fins appear at certain places only. From these come in the adult the separate odd fins. The caudal fin, which is at first perfectly symmetrical, afterward rises toward the back, and beneath the inflected vertebral column appear rays of fins. The tail passes through a heterocercal phase and afterward becomes homocercal.

Among the selachians, the eggs are bulky and there is much yolk. The vitelline sack is, as a general thing, more distinct from the embryo itself. It is pediculate and attached to the embryo by a sort of umbilical cord. Certain of these fishes are viriparous. The eggs, instead of being laid, are carried by the mother in her oviduct, wherein they develop. The vitelline sack may



THE ARGULA, A FISH PARASITE.

then graft itself upon the maternal tissues and constitute an organ physiologically comparable to the placenta of mammals.

The larval forms of fishes are sometimes so different from the adults that it is scarcely ever possible when a larva is caught to say to what fish it belongs unless the complete evolution of the species has been followed. Occasionally the larvæ do not assume the definite form of the adult until after quite a long time; so that naturalists have caught larvæ without recognizing the fact that they were such, and have considered them as distinct species and given them particular names. This has happened, for example, with regard to eels.

Another interesting example is afforded by the flat fishes—soles, turbots and flounders. The larvæ of these have in the first place the ordinary form of the fishes and swim with the back upward and belly downward. Then, at a given moment, they lie to the right or left and flatten themselves upon the ground. An eye is found at the contact with the bottom, and

THE ANGLER, FISHING-FROG, OR GOOSEFISH.

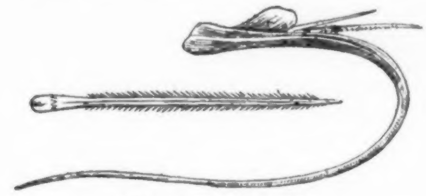
the young fish in trying to see with it twists the face to the side opposite that on which it is lying; so that after it has assumed its definite form its head is twisted and forever disfigured by a grimace fixed in the skeleton. This is all the same to the animal, which has reached its final form and now gazes upward with both eyes.

A metamorphosis still more curious yet, perhaps, is that of the lamprey. Its larva, which is of very different organization, is known under the name of "ammocela," and lives buried in the mud of water-courses, At the end of three or four years it attains a size equal to or even greater than that of the adult, and then becomes transformed quite abruptly into a lamprey. It is a true revolution of the organism. The eyes, which had remained concealed beneath the skin and in an embryo state, appear at the surface and become perfect. The skeleton is transformed and becomes complete, the bronchial apparatus is modified, and, while a portion of the digestive organ become atrophied, the genital organs develop and mature. The lamprey then lays its eggs and dies.

Diseases of Fishes.—Fishes are subject to numerous

MYXOSPORIDIA—FISH PARASITES—AS SEEN UNDER THE MICROSCOPE.

diseases. Their digestive tube, like our own, harbors worms of different kinds, and, although their skin is protected against fleas, it is, on the contrary, assailed by numerous suctorial crustaceans. These latter fix themselves by predilection upon the bronchiæ, where the blood offers them an abundance of food. They are minute as a general thing, and the fish nourishes them without being much discommoded thereby. But they sometimes become so numerous that they exhaust their host and finally cause it to perish through anæmia. Fishes have also their microbian maladies. They are,



TAIL OF THE RAY.

for example, often decimated by epidemics of myxosporidia.

Habits of Fishes.—Fishes are almost all of them carnivorous, and all live in the same manner and with the same needs in the waters of rivers and seas, the common field of their activity. There are few animals among which the struggle for existence is more bitter and cruel. They eat each other, and even in the same species the big devour the little and practise such cannibalism with frightful voracity. It is estimated, for example, that a pike must weekly eat

TORPEDO.

twice its weight of fish, and it is concluded therefrom that an individual of 16 or 20 pounds will, during his life, make way with several quintals of fish. Nature compensates for so enormous a consumption by the great fecundity of the finny tribe. The eggs of each female number hundreds of thousands, and of the prodigious issue derived therefrom, few are fortunate enough to pursue a very long career. Naturally those that are eaten do not always submit with good grace, and those that eat have to gain their repast by combat. There are changes of fortune in the latter, and ruses of attack and ruses of defence.

There are, for example, fishes that fish for their confreres with a line, such, for example, as the angler, or goosefish, a misshapen and sluggish animal with a disproportionate head followed by a narrow body reduced almost to a tail. It never could capture its prey by swimming, so it lies flat and well concealed upon a sandy bottom or in a tuft of seaweed and care-

lessly agitates the anterior rays of its dorsal fin, which is differentiated into angling filaments. An imprudent sole, attracted by this deceptive bait, arrives and is swallowed up in one mouthful. Certain fishes are provided with terrible weapons for combat. The sides of the little stickleback bristle with sharp spines that give food for reflection to the most hungry pike. Many of the rays have under the tail a barbed spine of which the sting is terrible. The sea-dragon, at the dorsal fin, presents rays that are extremely sharp, and the sting of which is accompanied with the emission of a formidable venom. The sting causes a very painful swelling and a general febrile state that may last for twenty-four hours. This weapon certainly protects the sea-dragon against the pursuit of certain voracious fishes, and fishermen, knowing the danger, promptly remove the spines after capturing one of these animals.

Another curious case is that of the electric fishes, the torpedo, for example. This is a sort of ray of harmless aspect. It has not an aggressive appearance, and has no sting under the tail. Novices do not hesitate to seize it, but do not hold it long in the hand, since the animal, a true electric battery, sends into the fingers that touch it a discharge that always surprises and may even prove painful if the fish is of a large size. The animal is capable of furnishing several successive discharges which continue to diminish in intensity. When exhausted it requires a certain length of time to recharge its battery. The electric apparatus occupies a great part of the body, in the lateral fleshy masses that in a ray would be occupied by the muscles. They are, moreover, transformed muscles controlled by large nerves and that are resolved into small columns formed of superposed hexagonal prisms.

Fishes that are unarmed try to escape by flight. Some have recourse to hereditary ruses and to tricks that are transmitted from father to son, so to speak. The flat fishes conceal themselves upon the sand in assuming the exact color of the bottom. Many fishes conceal themselves thus by their protective coloring. Others are more perfectly mimetic and imitate the objects by which they are surrounded so truly as often to be mistaken for them. Such are certain antennarii, which, concealed in holes in reefs, resemble a piece of madrepore, or the sea horses, the cutaneous appendages of which resemble foliaceous olgæ, with which they form a harmonious bouquet.—C. Perez, in the Revue Universelle.

THE SEA-HORSE, A MIMIC OF ALGÆ.

THE HYGIENE OF THE MOUTH.*

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A DISTINGUISHED contributor to medical literature makes the statement that the science of medicine during the century just closed, achieved its greatest triumphs in "Preventive Medicine." The profession, through local, state, and national boards of health, has advised proper regulations and sanitary measures for preventing the dissemination of those epidemic diseases which at times have threatened to depopulate the globe.

The term "prophylaxis" is derived from the Greek word meaning "I defend," or "to guard against." The prevention of disease stands to-day in the front rank of medical practice. To the practitioner of general medicine it is one of his most effective weapons against the common enemy, infection. It is of even greater importance to the "common people," as an efficient means of protection against the scourges, plagues, and contagions which afflict the people of those countries where ignorance, filth, superstition and uncleanliness abound.

In this age of rapid and quick communication, with its increased facilities for transportation, the dissemination of contagious diseases should be accelerated; but contemporaneously our knowledge of more perfect methods for the prevention and control of disease is correspondingly increased, thus allaying fears for the future and inspiring confidence in the investigations of science and the shield of protection which it affords.

The statement is made by Prof. Vaughan, in speaking of mental hygiene, that the mind must be studied from the view-point of the materialist; that the mind cannot be considered as an entity, dissociated from the brain, as the operations of the mind are merely the physiological phenomena of brain function; that a sound mind is dependent upon a sound body, and a sound body is dependent upon a perfect digestion, genius, even, being unable to compensate for the ill-temper produced by a faulty digestion. Logically may we not, therefore, go a step further and say that a perfect digestion is largely dependent upon, or is greatly influenced by a thorough mastication of the food, and that mastication is dependent upon a good set of teeth? Therefore the necessity for dental sanitary science, or dental surgery.

As it is practically impossible to be a good Christian when suffering from indigestion, regardless of theory and pretensions, mastication certainly, and salvation probably, in a great measure may depend upon the skill and knowledge of one's dentist.

If sanitary science is important in the practice of general medicine, it is of even greater importance in oral hygiene. The old but true axiom, that "cleanliness is next to godliness," may be applied to the oral cavity with pertinent and peculiarly appropriate fitness. In no other subdivision of personal hygiene are the sins of omission fraught with such disastrous and far-reaching consequences as are the disregarding and neglect of the sanitary principles of oral hygiene.

As mastication is an important feature of the digestive function, nature has provided suitable organs —the teeth—made not only for service, but also as one of the means of personal adornment when perfectly developed and cared for.

In the practical application of the principles of prophylaxis dental science goes further back in the scale of development than the consideration of the visible or developed teeth. Very much good can be accomplished for the teeth of the child, before its birth, by providing the mother with suitable foods, those which contain the essential elements for the formation of hard tissues, including the teeth, such as lime salts, etc., in the form of lime water (in milk), or the syrup of lactophosphate of lime; also certain grains, as wheat, and skim-milk. The latter furnishes a form of lime, the chloride (0.3 to 0.5 per cent), of which is very essential in building tooth substance.

After birth the tooth structure can be improved in the percentage of lime salts by the feeding of cow's milk, sterilized, which contains five times as much lime as human milk.

Parenthetically, a few words as to heredity may be of interest. Children inherit the individuality and peculiar characteristics of one or both parents, or perhaps of some remote ancestor. They inherit the complexion, the color of the hair and eyes, and the facial contour. They also inherit the peculiarities of the teeth, not only as to size, form, and position in the arch, but the constitutional structure as well.

Each of the four basal temperaments, sanguine, bilious, nervous and lymphatic, are characterized as to form, size, shade, position and texture. When a child inherits a certain temperament it should be endowed with the class of teeth that go with that temperament; though a child may inherit the small teeth of one parent and the massive maxillae of the other, or the reverse. In the latter case the teeth are crowded and irregular. The correction of such irregularities constitutes a separate department of dental science, termed orthodontia.

Next after development comes the subject of sanitation and cleanliness. The salivary and serumal calculus, which accumulates in some mouths very rapidly, necessitates its removal by a dentist every two or three months. Other mouths may not require this operation in as many years. In the case of young people, in the majority of instances the salivary calculus is the variety usually present. When removed, the surfaces of the teeth should be polished; a slightly roughened surface is favorable to, and induces future precipitation of the deposit.

The serumal variety—a deposit from the blood—is precipitated in the mouths of persons with a gouty or rheumatic diathesis, some of these cases being benefited by systemic treatment.

After the deposits have been thoroughly removed and the enamel surfaces polished, they may be kept so, by the patient himself, by the diligent and correct use of the toothbrush and other toilet articles, tooth powders, soaps, washes, picks, silk thread, rubber bands, etc.

The toothbrush—first, as to its selection. In form and size it should be suited to the case. It should be curved to fit the contour of the arch, and the handle also curved, to facilitate manipulation; the bristles firm and well fastened to the handle, with the surface serrated, and an isolated tuft at the end for cleansing the inaccessible surfaces of the teeth, as back of the third molar or in spaces where teeth have been extracted, etc. If the patient be so unfortunate as to wear a "bridge" or other stationary contrivance, then an accessory brush is usually required, a special form and size for these cases.

The correct use of the brush is an important item. To produce the best results, place the bristles against the outer or labial surfaces of the teeth, then brush from the necks of the teeth toward the occlusal surface. Pronate the forearm, or rotate the brush; brush the upper teeth down and the lower ones up (inner or lingual surfaces the same). This will tend to brush the gum festoons into the interdental spaces rather than out of them. The occlusal or masticating surfaces should be brushed from side to side, and forward and backward. This will cleanse the grooves and fissures.

Use the brush as though it were a collection of toothpicks designed to remove the residual food substances which may have become lodged between and around the teeth.

Don't brush across the gums under any circumstances. It will tear them loose from the teeth, unnecessarily bruising and lacerating them. Beware of infection! Do not scour the gums, nor scrub the teeth, nor try to polish them, using the brush as in polishing shoes. Dentists are provided with the proper instruments and utensils to perform such operations without injuring either the gums or the enamel of the teeth.

When oily or greasy films and stains accumulate which will not be removed by the brush and lukewarm water, then other agents of detergent character may be brought into requisition. Detergents may be classified into two kinds, chemical and mechanical or physical. Tooth powders belong to the mechanical. They are not of much importance as medicinal applications. The base should be alkaline and should be soluble in the oral fluids, and not too gritty; the grit should be regulated according to the condition of the teeth. Precipitated chalk is good for the basis; the grit can be increased by adding pulverized cuttlefish bone; as a solvent for fats and oils pulverized soap bark or white castile soap is added; and for sweetening use white sugar or saccharine and flavor with some aromatic substance.

TOOTH POWDER.

Precipitated chalk	10 ounces.
Pulv. cuttlefish bone	6 ounces.
Pulv. sugar	3 ounces.
Pulv. castile soap	1 ounce.

M. Flavor with oil of rose or the oil of wintergreen, and color with carmine.—N. S. Hoff, D.D.S.

This general formula can be changed to suit the conditions, but in no case use an insoluble grit such as pumice or charcoal. They work their way under the gingiva or free margins of the gums, establishing a nucleus for the precipitation of calculus and the accumulation of food substances, which latter furnishes a most desirable and comfortable habitat for microorganisms.

Soaps are chemical detergents which saponify the fats and oils on the teeth, but if used too frequently, or too long continued, will also attack the gums, eventually producing "recession," with consequent exposure of the necks of the teeth.

As a general rule, don't use toothpicks. If you do employ them don't use wooden ones, especially those which are cut—they will splinter; but rather those round, pointed ones, made of hard wood. In the use of picks beware of splinters and infection. Goosequill toothpicks are the least objectionable when used once or under antiseptic conditions. They are now put on the market in convenient form, with a detachable quill-point in a holder, the latter made telescopic, like a fountain pen, so it may be closed up from dust and dirt (infection).

To properly cleanse the approximal and interdental spaces in some mouths becomes a task. The difficulty may be overcome by using silk floss, which is smooth and should be waxed.

By using moderate pressure, accompanied by a sawing movement, a rubber strip will pass between the teeth quite readily and is useful for polishing the approximal surfaces. Some tooth powder may be added to the silk floss or the rubber band to accomplish thorough cleansing.

TOOTH WASHES.

These are medicinal applications, but may be detergent also. The fundamental principle, however, is that of asepsis. For general use the antiseptic in the formula may be phenol 2 per cent or formalin 2 per cent. Alkalinity may be furnished by the bi-borate of sodium or the benzoate of sodium. The solvent in the tooth wash is alcohol and the diluent is distilled water. Sweeten with saccharine, instead of sugar, as it has antiseptic properties. Flavor with essential oils and color with cochineal.

TOOTH WASH.

Saccharine	10 grains.
Sodium bi-carbonate	10 grains.
Spirit	10 drachms.
Salicylic acid	10 grains.

S. Ten to fifteen drops in a little water or on a wet brush, after the teeth are cleaned; brush teeth and gums gently.—(Hoff.)

A mouth wash for general use should not be irritating, but pleasant to the taste. Special conditions require specific mouth washes. A prevalent idea, that all mouth washes should be astringent, is erroneous. Such are required in some cases, but when too frequently used, or too long continued, they will react and produce chronic inflammation of the gums, or an atrophied condition results. Weak alkalies, long used, will produce an atrophied result also.

The best method of application of a mouth wash is by means of a brush. After the teeth are thoroughly cleaned, add ten or fifteen drops to the wet brush and brush the teeth and gums gently. The medicine may be used as a gargle or wash, in suppurative conditions, inflammations, etc.

MOUTH WASH.

Thymic acid	¾	drachms.
Benzoic acid	3	drachms.
Bi-chlorid	¾	drachms.
Tinct. eucalyptus	15	drachms.
Alcohol—absolute	12½	ounces.
Oil wintergreen	25	minims.

M. S.—Fifteen to 20 drops in one-third tumbler of water.—(Miller.)

Green stain is a fungous growth upon the teeth of the mold species. This vegetable garden (it can hardly be classed as ornamental, therefore, not a flower-bed), develops and grows in an acid medium. The presence of green stain indicates an acid mucus

* Dental Register.

This acid has two sources of origin, fermentation and secretion. Under certain conditions gums and soft tissues, when irritated and inflamed, or by reason of constitutional or functional derangement, will secrete a viscid and acid fluid which attacks the tooth, producing erosion.

This acidity requires treatment by the dental physician, both local and systemic. The local treatment consists of a process of neutralization by an alkali, best accomplished by milk of magnesia. This magnesium hydrate is not only alkaline, but it is also antiseptic. In a strength of 1 to 2,000 it is antiseptic, or prevents the growth of the strepto coccus pyogenes.

Functional derangements of the oral tissues and membranes, such as catarrhal inflammations or reflex irritations from digestive disturbances, also those produced by eructations from the stomach, require special additional treatment.

BACTERIA FUNGI.

The part played by bacteria and fungi in the pathology of the mouth is an interesting topic. The effects produced may be classified into two groups, those which affect the soft tissues and those which disease the hard structures, the teeth. Of the affections of soft tissue may be mentioned thrush, a membranous disease produced by a mold.

Yeast produces fermentations, and is now being accused of producing cancer. This question is still under investigation.

Bacillus tuberculosis is actively represented in lupus, a mouth disease, being a variety of skin tuberculosis. Of the other pathogenic bacteria we might mention those of bacillus diphtheria, pneumonia, croupos, Franckel's diplococcus, streptococcus pyogenes, and a number of vibriones, bacilli and spirochaetes which can be grown upon artificial media.

Of the acids produced in the mouth we have lactic, butyric, acetic, etc. Of the pus micro organisms, there are myriads of them.

Whenever the tissues become less resistant or below normal, through impaired nutrition, wounds or traumatic lesion, then the invasion begins, the campaign being waged so persistently and vigorously that septicaemia pyemia and death often result.

Of the purulent conditions the most serious ones are antral abcess and dentigerous cysts; of abcesses of the oral cavity we have the whole family, from the superficial gum boil to the deep-seated alveolar abcess; abcesses which see with one or more eyes (fistula) and those which do not see, in fact totally "blind"; those which are hot, feverish and acute, and those which are "cold," indolent and slumbering. Special treatment is indicated for each condition.

THE TEETH.

The greatest havoc wrought in the mouth by bacteria or the condition most keenly realized by the patient, perhaps, is that of caries, or decay of the teeth.

The process of decay, briefly stated, is as follows: The starches of the food residuum are converted by ptyalin into maltose; maltose undergoing fermentation by a bacillus, produces lactic acid; the acid dissolves the lime salts of the enamel and dentin, the organic matrix remaining becoming liquefied or decomposed by other bacteria, those producing soluble ferments in either acid or alkaline media, the by-product then becoming food for saprophitic or other putrefactive micro-organisms. Each species in turn performs a certain and definite work, and is finally killed by its own toxin or product. This product, which was a poison to the former tenant, now becomes food for the subsequent occupant. The process continues till complete disorganization of the complex molecule is accomplished.

An important fact to be remembered is, that the very first step in the process of decay is the production of acid; and in the majority of instances that acid is a product of bacterial fermentation as a result of the uncleanliness of the teeth.

What shall we do for that bad breath? Remove the cause which is producing it. Temporarily, as an expedient, a deodorant will either mask or destroy the odor. In the latter case the gas is made to form a chemical compound by uniting with some other chemical substance. The fetid breath is caused by derangement of the stomach and intestinal organs, or it may be a putrid condition of the oral cavity. For proper treatment consult a dentist.

As may be inferred from the outline given of some of the operations and treatments to be performed by an oral physician or surgeon, the dentist of the future must know more than to merely extract a tooth and make a plate, or to insert a gold filling and build a bridge.

The dentist should know enough about the sciences of bacteriology and pathology to realize the importance of asepsis in all operations upon the oral tissues; not merely mechanical cleanliness, but surgical and bacterial also. The latter training can only be acquired in a well-regulated bacteriological laboratory.

SUGAR AS A FOOD.

One can, without much effort of memory, recall those days when physicians inveighed in grave terms against the use of sugar. Mothers were warned of the injury to the health of their offspring which would assuredly follow the consumption of sugar in any but the most sparing quantities, says The Medical Record.

Sugar was "heating"; it caused constipation, and required a large amount of gastric juice to digest it properly. Moreover, it affected injuriously the respiratory organs and favored the production of intestinal worms. Now, *nous avons changé tout cela*, and more enlightened views prevail. In various countries physicians became convinced of the errors of their ways, one of the first converts to the belief that sugar is a healthful food being Michel Levy, the well-known French hygienist. Proudhon and Cruveilhier support these views, the former of whom was the author of the aphorism that "sugar constitutes the poor man's pharmacy," his pocket alone suffering.

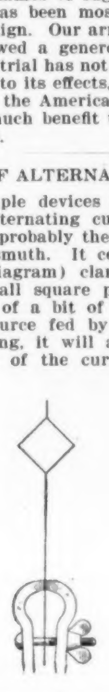
At the present time sugar from being almost universally condemned, has been advanced to a pedestal in the dietary list, and bids fair—unless due discretion be used in its consumption—to lead its lovers into excess with its consequent evil effects.

However, the truth that sugar is a valuable food cannot be gainsaid, and when, as stated recently in an editorial in the Sun, it is learned that its consumption has doubled for the world in fifteen years, and that in Great Britain it is three times as great per capita as it was forty years ago, a good idea will be had of the appreciation with which the saccharine matter is regarded by the present generation. The Sun in the same editorial also refers to an interesting article by Dr. H. Willoughby Gardner on the dietetic value of sugar, in which he points out that it is easily digested and absorbed into the system; it is readily stored up as glycogen, forming a reserve of force-producing material; it is in this form readily available when required; it becomes completely oxidized without any waste, and leaves no residue. Dr. Gardner, who is an enthusiast as regards the merits of sugar, attributes to the fact that the British people are the largest consumers of sugar in the world, the reason that they have so greatly increased in height, weight, and health in the past half-century.

The German army authorities in 1897 made some experiments with regard to the sustaining and invigorating properties of sugar, which proved conclusively that it is an adjunct to the soldier's diet of almost inestimable value. It was declared that a few lumps of sugar acted like a charm against fatigue as well as in quenching thirst. The British government followed the example set it by the Germans, and now provides its soldiers with 37 grammes of sugar daily. The result of the experiment has been most satisfactory in the South African campaign. Our army, too, in its revised ration scale, is allowed a generous amount of sweet food, but the time of trial has not yet been long enough to pass judgment as to its effects, although there is no reason to doubt that the American soldier will assimilate sugar with as much benefit to his health as have his European fellows.

FREQUENCY OF ALTERNATE CURRENTS.

A good many simple devices for determining the periodicity of an alternating current have been described already, but probably the simplest yet devised is that of R. Wachsmuth. It consists of a piece of watch-spring (see diagram) clamped in a vice, and provided with a small square piece of white paper stuck on by means of a bit of wax. When this is illuminated by a source fed by an alternating current and set vibrating, it will appear to stand still when the frequency of the current equals its own



frequency of oscillation. The latter can be calculated from the formula, $N = 7,920$ thickness in mm. / (length in cm.)^2, but in practice a graduation could be easily marked on the spring itself. A small correction must be added for the paper in the case of light springs. The method is very convenient, and can be used for frequencies up to 150 per second, beyond which the springs become too stiff.—R. Wachsmuth, Ann. der Physik, No. 2, 1901.

CONTEMPORARY ELECTRICAL SCIENCE.*

Cutaneous Thermocouples.—In the course of some elaborate experiments on the thermal conductivity of the human skin, J. Lefèvre found it necessary to devise special forms of thermocouples for determining the temperature of the skin and the temperature 2 millimeters below its surface. The first type consisted of a small box of ebonite having a metallic lid sunk a little below the rim. The lid consists of a central circle of iron surrounded by a concentric circle of German silver. The two disks form the junction of a thermocouple. It is devised as described in order to enable the operator to find the temperature of a submerged portion of the skin. For the author carries out calorimetric experiments on human subjects on a large scale, the subjects being immersed in water and fixed in position so as to avoid convection of heat. To find the internal temperature of the skin the author employs a small pointed probe consisting of a concentric iron-German-silver couple, the projecting point being 2 millimeters long, and plunged into the skin until the handle is flush with the surface. The experiments so far go to show that at a temperature of 5 deg. the conductivity of the skin is only one-sixth of what it is at 30 deg. On the whole, the loss of heat is greater than would follow from Newton's Law.—J. Lefèvre, Jour. de Phys., June, 1901.

Aluminium Rectifiers.—C. Pollak has made his aluminium rectifiers available for currents of a voltage of 200. For this purpose he employs a slightly acid solution of potassium phosphate traversed by a continuous current. The aluminium plates are first macerated for some time in caustic soda, so as to get rid of impurities. A crust is formed on them, consisting of oxides and other compounds of aluminium. This crust is necessary for their proper action. It remains unaltered in air, but gradually disintegrates in water, and must, therefore, be preserved when out of action by taking the plates out of the dielectric. When in action they must not be allowed to reach a temperature above 40 deg., as otherwise they allow a considerable proportion of the current to pass both ways. This is avoided by making the column of liquid several times the length of the plates. Convection and radiation then bring about the proper cooling. It is thus possible to use an aluminium cell continuously for four hours without overheating. The life of a plate when used at the proper temperature is 500 to 800 hours. At the end of that time, the oxidized layer begins to crumble away, largely owing to the mechanical friction of the hydrogen bubbles. It is not practicable to employ several cells in series unless they can be made precisely equal.—C. Pollak, Comptes Rendus, June 10, 1901.

An Electric Fire-Damp Meter.—The fire damp indicators at present in use are based upon the aureoles shown by safety lamps when fire damp is about. They do not indicate its presence below at least 2 per cent. Pieler, by using an alcohol flame, reduced this limit to 0.25 per cent, and Chesneau, with a flame colored by cuprous chloride, further reduced it to 0.1 per cent. Liveing's glowing wires, one of which is surrounded by air and the other by fire damp, show about 0.5 per cent of the dangerous gas by a difference of brightness. This has been improved upon by G. Léon, who compares, not their brightness, but their resistances. The two platinum wires are heated to 1,000 deg. by the same current, and one of them is encased in a glass tube full of air, while the other is surrounded by a double layer of wire gauze. The deflections of the Wheatstone bridge galvanometer are sensibly proportional to the amount of fire damp contained in the air, and a deflection of four scale divisions corresponds to a proportion of 0.2 per cent. A maximum deflection is attained when the proportion of fire damp is 10 per cent. It may, therefore, happen that a reading is ambiguous. It may be definitely determined by admitting some fire damp to the protected wire, and noticing whether the deflection increases or diminishes.—G Léon, Comptes Rendus, June 10, 1901.

Vibrations Due to an Influence Machine.—If one of the poles of a Wimshurst exciter is connected with the end of a stretched wire which is insulated and contained in a tube, and the other pole of the machine is put to earth, the wire executes transverse vibrations. D. Negreano has observed that when the wire is watched in the dark it shows alternate dark and luminous portions. If the wire is attached to the positive pole of the machine the luminous portions are equidistant, and are wider in the center than at the ends. On attaching the wire to the negative pole it is seen that the lines become equidistant luminous points. The experiments were made with a tube 2.5 meters long and 6 centimeters in diameter, and a wire 2.5 millimeters in diameter. Somewhat similar experiments made by Bezold, Tommasina, and Viol have been explained on the supposition of mechanical vibrations, in which the luminous portions represent the nodes. The experiment succeeds very well when two wires are used, one attached to the positive and the other to the negative pole. The wires both show their characteristic light effects. If the two wires are close enough together the experiment succeeds equally well on attaching one wire to a pole, and connecting the other with earth. The two wires then, so to speak, form the armatures of a condenser.—D. Negreano, Comptes Rendus, June 10, 1901.

Frequency Indicators.—A handy method of indicating alternate current frequencies is a great desideratum in central station work. A large number of different systems have been devised, and another is added to the number already available by R. Kempf-Hartmann. It is intended strictly as a workshop instrument, which is to enable the engineer to tell the frequency of the current at a glance, by reading it off in whole figures. Tuning forks are not very suitable for this kind of work, as they resound to a strictly limited range of frequencies above and below their proper pitch; and to be certain of some resonance in a graduated series, it would be necessary to make their successive pitches differ by less than ½ per cent. The author therefore employs "reeds" of steel, weighted at the ends and actuated by an electromagnet excited by the current to be measured. Each reed is fixed in a clamp, having its frequency marked on it in a series such as 100, 101, 102. The amplitude at resonance attains as much as 3 centimeters. At least three reeds correspond to each frequency, and their relative amplitude allows the observer to estimate the frequency to the first decimal place. By a suitable subdivision of the magnet it is possible to sound an "alarm" as soon as the frequency rises above the normal value or falls below it.—R. Kempf-Hartmann, Phys. Zeitschr., June 15, 1901.

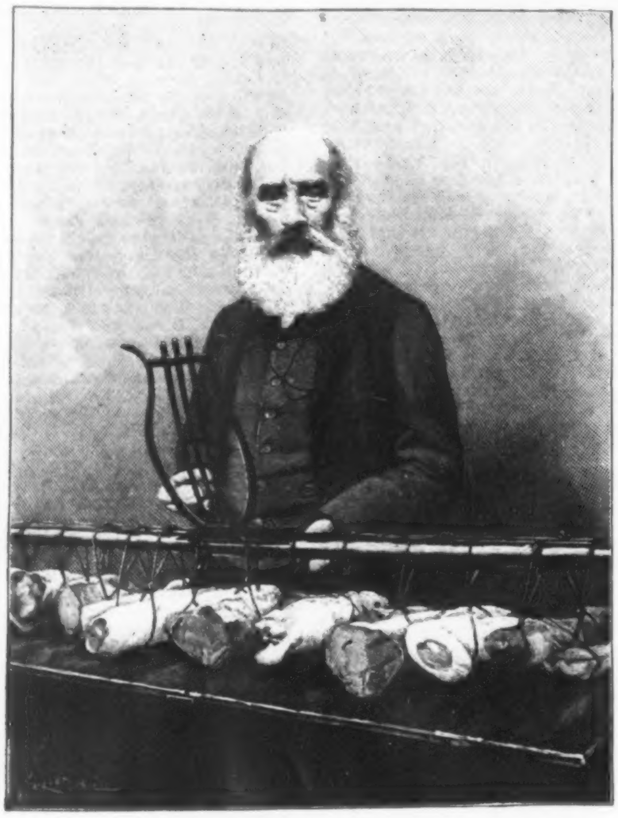
Anti-Coherers.—A. Neugschwender, known as the inventor of the first "anti-coherer," criticises the explanation given by Marx of the action of the so-called Schäfer plate (see The Electrician, Vol. xlvi., p. 611), which consists of a silver-on-glass deposit gapped with a razor covered with a layer of celluloid. He points out that the action of this "dry" anti-coherer is probably as much of an electrolytic action as that described in his own device, which consisted of a similar gap moistened by breathing upon it. Marx's instruction to exhaust the air about the anti-coherer and re-admit it is inconsistent with the "absolute dryness" of the plate, and the fact that at a very low pressure the action of the coherer becomes nullified is probably explained by the absence of moisture in that case. The re-establishment of the tree-structures on the cessation of the electric waves cannot be due to any mechanical action or precipitation, since the metal would probably only be precipitated in an oxidized state. Indeed, when the mirror is made of gold or platinum, the anti-coherer fails, though a metallic deposit might be expected to take place in the gap. The true explanation is that these metals are so insoluble in the traces of moisture that no solution is formed from which trees of gold or platinum can be deposited.—A. Neugschwender, Phys. Zeitschr., June 15, 1901.

* Compiled by E. E. Fournier d'Albe, in The Electrician.

Cable Service to Tampico.—Consul Magill reports from Tampico, June 20, 1901, that the office of the Mexican Telegraph Company at that place is closed to the public service, thus severing the direct connection with Galveston, Tex. Foreign messages will hereafter be routed via Laredo, Tex., overland, or via cable to Vera Cruz, and thence overland to Tampico.

A FLINT-STONE PIANO.

In a small town of India there lives a man who possesses a collection which is doubtless unique of its kind, and that is a collection of sonorous stones. These stones have nothing in common with those that geologists call phonolites, or clinkstones, some remarkable specimens of which exist in Huvergue, not far from Mount Dore. The flint-stones collected by M. Honoré Baudre, for such is the individual's name, have other qualities—they sing in chorus. One day, in walking through the fields, M. Baudre, by one of those accidents that occur at the threshold of every invention, discovered that a flint-stone that he had picked up gave, when slightly suspended and struck, a very pleasing sound. The idea then occurred to him to make a collection of such vibrating stones, and so he began to search for the flint-stones necessary to form two complete chromatic scales. But "there's many a slip 'twixt the cup and the lip." M. Baudre very quickly discovered that stones that sing, and especially those that sing in tune, are exceedingly rare. Greatly excited by degrees by the difficulties attending this novel hunt, he became enthusiastic over the subject, and the materialization of the musical instrument that he styles a "geological piano" soon became the principal object of his existence.



M. HONORÉ BAUDRE AT HIS GEOLOGICAL PIANO.

For thirty or more years of his life he traveled over every piece of ground where, among the rough flint-stones of the chalk, sonorous stones might be found. During all these years he tested, day by day and one by one, thousands and thousands of specimens. This operation was quite complicated. It was necessary in each case to suspend the stone by means of string, to strike it, to listen and to judge of the quality of the sound. It required the practised ear of the musician, backed by an angelic perseverance, or, to put it in other words, a superb persistency. The patience of Penelope, as compared with the untiring perseverance of M. Baudre, is unworthy of mention.

In order to form his orchestra, the collector, after he had exhausted all the sources in the vicinity, extended his researches farther and farther. He thus traveled over miles upon miles of territory in causing the stones found on his way to sing, and when, once or twice a year, he met with an ideal flint-stone—one that sounded correctly and vibrated freely—he was happy and felt rewarded for his trouble. Then he wrapped the stone up in wadding and carried off his treasure as if jealous of or in love with it.

Accident, always full of malice, played all sorts of mean tricks with M. Baudre. It seemed as if Satan were amusing himself with the disappointments of the collector. For a number of years, while there was a full complement of the other notes, it was impossible to find the first *do* of the scale. This first *do* became a subject of worry to M. Baudre—the object of his thoughts by day and his dreams by night. For this note that had escaped him the collector would have given half of his fortune. For a moment he was almost convinced that this *do* did not exist in nature, at least in France. For this note he took a steamer and went to Canada, but the earth of the New World did not conceal the initial sound of the octave. Weary and resigned, M. Baudre returned from his long voyage, persuaded that he would die without having heard a stone sing this famous note, when one morning while taking a walk in Berry, still hoping and yet despairing, he came across a flint-stone that vibrated in *do* most exquisitely. On this day our collector experienced a feeling of joy that could be compared only to the absolute beatitude that awaits pure souls in paradise.

By an accident that seems likewise to indicate a genuine will of fate, the last *do* of the second scale has remained undiscoverable; but this note is not indispensable, and its absence does not prevent the execution of very varied airs.

The singing flint-stones affect strange and suggestive forms. They are all elongated, but nature has provided them with various more or less fantastic protuberances and with blended colors varying from light gray to black, and of a curious effect. Some recall the figures of animals. Thus, a sharp *sol* is formed of a petrified pike. The unfortunate fish, doubtless, in antediluvian epochs, met with a Medusa. The *mi* of the first octave is a superb prehistoric flint—an axe of the stone age. Just think of the strange adventures of this stone, of old a woodman's tool or a weapon of war in the hands of our primitive and hairy ancestors, that, thanks, to M. Baudre and to destiny, has become a note of music vibrating at will for great operatic airs, for ditties, or for the Marseillaise. * * * *Quantum mutatus ab illo!*

This prehistoric *mi* leads to a hypothesis that, perhaps, does not signify a great deal, but is nevertheless worth as much as many others proposed on the subject of problems lost in the obscurity of time, and the first elements of the discussion of which are wanting. The men of the stone age who skillfully worked flint, and who worked this material in a thousand different manners, must certainly have been aware of the harmonious qualities of some of these stones. It may be, then, that one of the first musical instruments was a keyboard of precisely the style of that of M. Baudre. Were this not so, there would be something new under the sun.

The quality of the sound varies greatly, according to the notes of the geological piano. Some are wanting in amplitude in their vibrations and sound dull. Others, on the contrary, resound with a marvelous *timbre*, at once strong and clear, somewhat analogous to that of a silver bell. The sharp *do*, for example, formed of a flat stone, is wanting, so to speak, in breadth, while the sharp *re* and *fa* charm the ear in the most harmonious manner.

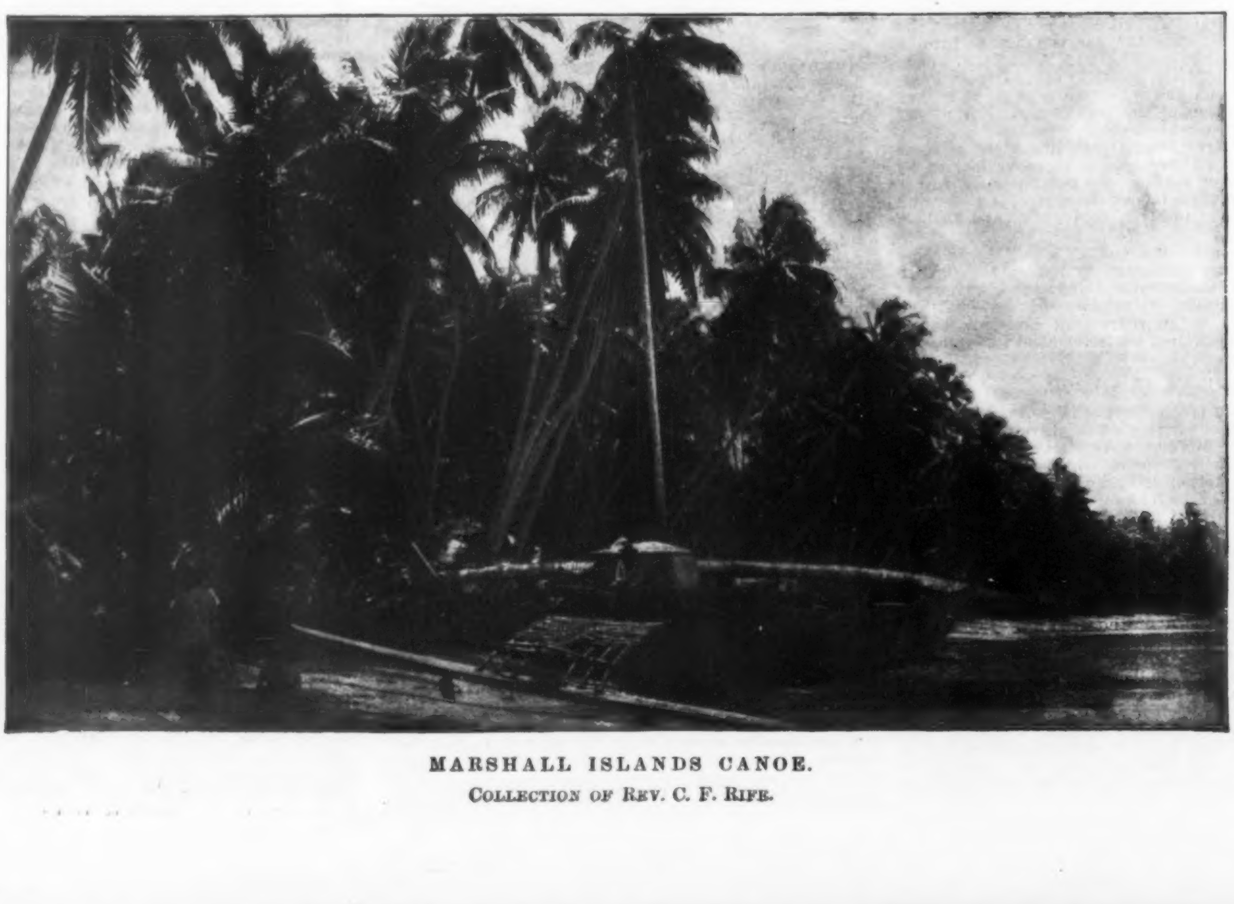
The geological piano is formed of an iron frame from which the flint stones are suspended horizontally at the end of double strings. In order to produce the sound, the stones must be struck with a hard instrument. The best result is obtained by means of a small flint stone held simply in the hand. The force of the vibration is not equal upon the entire surface of the stones. If a person wishes to play like a virtuoso, it is therefore necessary for him to know the sensitive place of each key.—For the above particulars and the engraving, we are indebted to L'Illustration.

ON SEA CHARTS FORMERLY USED IN THE MARSHALL ISLANDS, WITH NOTICES ON THE NAVIGATION OF THESE ISLANDERS IN GENERAL.*

By Captain Winkler, of the German Navy.

In July, 1896, I was stationed for a short time in Jaluit, on the Marshall Islands, during the annual

*Translated from Marine Rundschau, Berlin, 1898, pt. 10, pp. 1418-1439, with plates from the United States National Museum and other collections.—From the Annual Report of the Smithsonian Institution for 1899.



MARSHALL ISLANDS CANOE.

Collection of Rev. C. F. Rife.

circuit of inspection. While there I received from Dr. Irmer, royal inspector of lands, among other things, two sea charts of the Marshall Islanders, made of a number of sticks lashed together in a rude lattice-work, and on this at various points were tied small shells. Dr. Irmer confessed that he was unable to explain the meaning and function of the charts, for great secrecy was preserved among the islanders on this score, and only a few of the old chiefs, indeed, were in possession of the secret. He had sought to secure their interpretation in his official capacity, but to no purpose. He laid it on my conscience, since ethnologists are greatly interested in such matters, and since a thorough explanation of the charts had not been made, to try my skill therein, and he promised to bring all his influence to bear in my behalf to this end.

The chief, Lojak, who was one of the most skillful local pilots, was induced to give me his interpretations, which Dr. Irmer's native servant, Ladjur, would interpret. One forenoon an impressive scene was enacted in Dr. Irmer's quarters, when Lojak, with the greatest secrecy, first closed all the windows, in spite of the 34 deg. C. heat, having threatened Ladjur with death if he divulged the tabooed mystery; but the result of the long sweat bath was a complete negative. From other persons on the archipelago I gathered what they had learned concerning the interpretation of the charts, to the effect that the mussels on them indicated the islands and that the sticks represented the currents, that the natives knew these currents, and that on a journey one man from the bow of the canoe looked over the water and in the easiest manner, by the water indications and the chart, directed his course.

All my objections that the current cannot be seen in open water, and all my cross-questionings to secure a more reasonable explanation, availed nothing, so that I had to content myself with this, coming to the conclusion that the Marshall Islanders must possess a sixth sense, lacking in us, which enabled them to perceive more than we. As I afterward found out, this misunderstanding was altogether due to false interpretation, coupled with my own limited experience in following the thought and expressions of the natives.

Both charts were hung in my cabin, and the next year, during my stay in the South Sea, Australia and New Zealand, because of their construction, they formed the theme of many a conversation with my visitors, especially English naval officers and gentlemen in Sydney and New Zealand familiar with the Pacific Ocean. The same testimony came from all, that no one could tell the use of the charts, but the greatest interest was shown and a desire to know more about them.

In 1897, shortly before I made a second cruise to the Marshall Islands, I was interested to meet in Samoa the explorer, Dr. Benedict Friedlander, who begged me, when convenient, to seek an explanation of the mysterious charts, saying that the Polynesian Society, of which he was a member, would lay great stress upon the investigation. Dr. Friedlander also gave me a drawing of one of the two charts now in my possession, which had been illustrated in the Polynesian Society's Journal, with the request to seek the decipherment of the lines thereon. For explanation of the chart there was merely the assertion that they were a means "to teach the youth the direction of the currents."

So I determined to do my best on my second cruise, and I believe that, favored by fortune, since I had the kind assistance of two officials as interpreters, I made out a tolerably correct explanation, which I will now set forth. The publication of my results was made in the Marine Rundschau, so as to render them accessible to all my comrades who might have the opportunity to study more extensively in order to come to a complete solution of the problem. If something has been already attained herein, still there must be haste. The Marshall Islanders now make their longer journeys only in European-built schooners, with the aid of a compass, using charts of the archipelago issued by us, and prefer the patent log. The employment of the old charts was only little known, and they are no longer studied, so that, in fact, on the islands, no further information about the use of the charts is to be had.

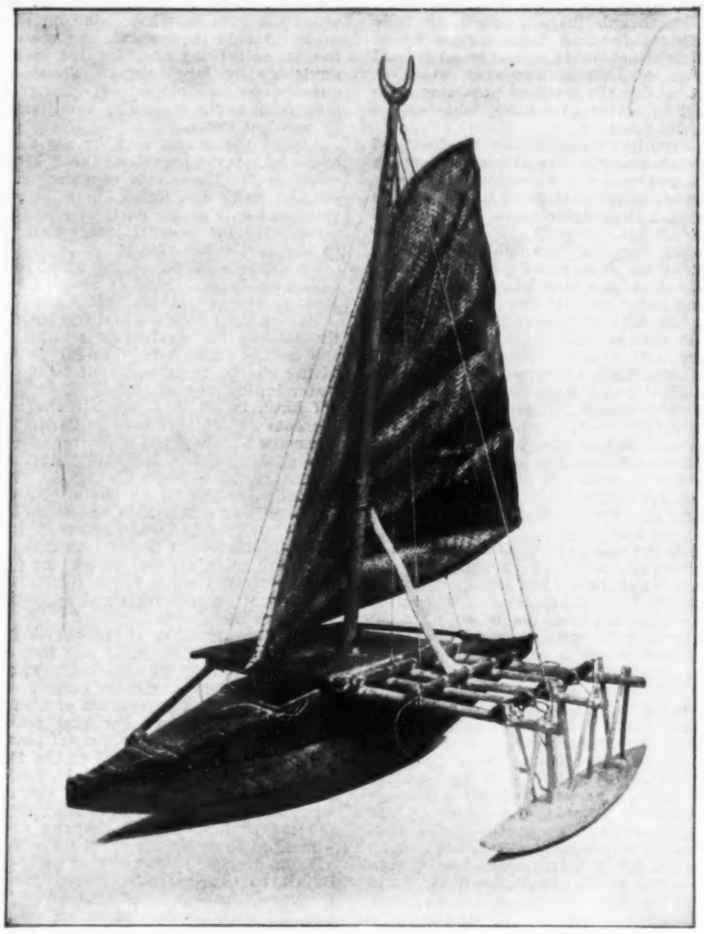
In order to give the greatest possible number of hints to those who wish to pursue the subject further, I shall here report the sources from which I have obtained my information and the names of those natives from whom, perhaps, something more may be gained.

In the second cruise of His Majesty's ship "Bussard" to Jaluit, in November, 1897, I observed lying at anchor the German schooner "Neptune," Captain Kessler. He had already spent a decade in the Marshall and Gilbert groups, was quite familiar with the native languages, and friendly with the chiefs, with one of whom, Nelu, he was in fraternal relations. Now I had someone who could help me. Captain Kessler, who had no accurate knowledge concerning the charts, nevertheless showed the greatest willingness and interest and promised hearty co-operation.

Then began a strenuous, monotonous, and patient research. Chief Nelu, who did not wish to conceal aught from his brother Kessler, was first pumped. He told us all that he knew, and gave us pleasure with his willingness, but when, in the evening, I collected all that had been heard and noted down, and tried to put it into form, I found so many contradictions that pretty much all that had been written had to be crossed out. We came to the conclusion that Nelu was not sufficiently trained, and through incessant drinking of beer, which furnished his sole nourishment, had become too stupid to be able to render a clear explanation.

It was now necessary to look up Chief Lojak, who at first was not willing to speak out plainly, but when he heard that Nelu had told us all he knew, was more cordial and willing to answer questions. Here also great patience was demanded. These hour-long sessions and squeezings were not to the liking of the king, as he called himself. It was not easy for him to express himself correctly, and frequently we had to interrupt our sessions when his confusion became uncomfortable.

Once Lojak told me, with seeming frankness, that I was the dumbest churl he had ever seen; daily he told me the same, and that every day I came again with the same stupid questions; generally he would have no more to say to me, and only a glass of sack.



MODEL OF MARSHALL ISLANDS CANOE, WITH SAIL SET.

UNITED STATES NATIONAL MUSEUM COLLECTION.

HULL OF MARSHALL ISLANDS CANOE, SHOWING STRUCTURE.

UNITED STATES NATIONAL MUSEUM COLLECTION.

which the old man loved, would make him friendly again.

As an extreme measure, I had hanging in my cabin a showy uniform coat which I promised Lojak if he would answer all my questions. The hint had its effect, for another chief frequently in company with Lojak, named Kabua, had before that received from a commandant such a garment, in which he, much to Lojak's envy, had appeared on festive occasions. To have in sight a better coat seemed to him a piece of the best luck that could happen.

In gathering help from all sides, we came upon another good leader, though there stood many wide gaps in our knowledge; for now fortune gave me an exceptional help in the person of a half-breed named Joachim de Brun, called Jochem, who came to Jaluit once in a while to consult the resident physician. He was the son of a Portuguese in Likieb, who built a schooner for the chief there.

Jochem was an intelligent man, spoke English and the Marshall language, knew well the islanders, among whom he grew up, and was also a good sailor. After Jochem had taken part in our conferences, he remarked that Lojak did not get the matter quite straight, and did not understand it all correctly; he did not say the same thing every day; he was not competent to do that, because his chief assistant in sailing was always a native of lower rank, called Laumanuan, who was now living with Lojak. It did not seem expedient for the present to use him to correct his chief when he was in error, but Jochem could privately learn from him afterward, especially at home, the correct version. In this inquiry, when things were not clear, I had a conference with Lojak in his hut while Jochem and Laumanuan remained outside. At last, in this way, we succeeded in clearing up the greater part of the doubtful points and securing the interpretation of the charts, as well as the meaning of their symbols. Moreover, we obtained, through our efforts with Lojak, a new chart from Chief Langenat, of the island Mille, in the Ratak chain, who was at that time a guest of Lojak's.

As reported to me, the other chiefs understood little more of the ancient lore, only Chief Muridjil, in the northern part of the Ratak chain, had some reputation as an old sailor. From Jochem's statement, this man's knowledge would turn out not much better than Lojak's. Muridjil had a native named Burido as assistant and right-hand man, who was required to be versed in the sailor's art. In Jaluit were also Chiefs Kabua, Litokwa and Launa, who were skillful men, but Kabua was not there on my second visit. Litokwa and Launa knew less than Lojak about interpreting the charts.

General results have been enlarged for me in a valuable manner by an aged man, Mr. Capelle, in Jaluit, known under the name of "the old gentleman," a merchant living there, who had been already more than thirty years on the islands, and formerly was one of the best-informed settlers in the South Sea. Misfortune had overtaken him in business, but now he was getting on his feet again. Mr. Capelle had, during his entire sojourn in the South Sea, kept a diary, from which he had given me notes on the subject in hand, and out of which, when it was properly classified, was furnished other interesting material.

In the same manner as to Captain Kessler and Joachim de Brun, I owe also to the imperial magistrate, Herr Senfft; to the president of the Jaluit Society, Herr Huetier, and to other gentlemen of Jaluit, many thanks for their substantial help in my work, both through their own efforts and their influence with the natives.

The so-called charts do not deserve the name in our sense, but they merely serve to bring to view the water condition, as well for the instruction of the chief's sons, who have to be initiated into the secrets of navigation, as for the settling of differences between chiefs piloting a boat when the water indications are not plain and varying interpretations have been made. Only in one chart, in the first line, can the geographic positions of the islands be made out.

As already said, the charts consist of a system of little sticks tied together, with shells fastened on them. The mussels represent neither determined nor undetermined islands. The sticks are designed chiefly to bring to view the direction of the principal dunungs* (not the currents, as was formerly explained to me erroneously), the course of these in their contact with the islands, and they are used in discussions arising concerning the crossings of the different dunungs, which furnish the principal guides for navigation. Moreover, the several sticks indicate the visible distances of the islands, as well as some other lore useful in sailing. All these will be made clear in describing the charts. Before proceeding to the descriptions, it is necessary previously to give the meaning of certain native terms, since I shall, in describing the charts, repeat without translation only the Marshall Islands expressions as they were delivered to me by the chiefs. In my interviews with them, in order to eliminate errors, the terms under consideration were always written with pencil on the chart when they were not involved in the general explanation. I have inserted the necessary verification in the proper place.†

By a more careful scientific study some of the explanations, which did not at first appear tenable to me, may seem open to dispute. I must, therefore, emphasize the fact that I here give no theories that I have adopted and will eventually maintain, but repeat only the explanations furnished me, as the Marshall Islanders themselves have laid them down, and they answer to the conceptions held by them, and whose correctness I had no opportunity to control.

The directions are different, but the islanders know these and use them in orienting themselves. The Marshall group is made up chiefly of atolls, or reefs, about the islands, whose continuity is broken by passages. Inside these encircling reefs are found water basins, called lagoons, for the most part open and navigable by large ships. These lagoons have frequently considerable extent; that of Jaluit is 32 miles long from north to south; the greatest width reaches 20 nautical miles.

Among the charts seen by me and those that have come into my possession, three kinds are to be discriminated: Those that represent the entire group of islands, Ralik and Ratak chain together; those which represent only single parts of groups, and those which serve only for general instruction without referring to any particular islands.

The charts of an entire group or of a chain are called Rebbelib; those of smaller sections of groups, Meddo; the instruction charts are termed Mattang.

But on the Rebbelibs and the Meddos the locating of the islands for navigation is about the same, since the sailing extends only so far as to pass, by means of the charts, from one atoll to the next through the water indications on them.

I have, in all, five separate charts deposited in the Museum für Völkerkunde in Berlin, where they may be inspected.* They are a Mattang, a Rebbelib for the whole island group, a Meddo for the southwestern part of the group, a Rebbelib for the Ralik chain, and a Rebbelib for the Ratak chain. Now these charts are not generally serviceable and established in the forms given, but they are made by chiefs for their individual use as reminders of the various things which they have to attend to in sailing, as well as for rendering clear the noteworthy signs in the tuition of the uninitiated. Hence the repeated false and apparently wild information from the sticks.

The interpretation of the charts is, for the reasons stated, always difficult, if one has not the maker of the chart himself as explainer; another, even an entirely competent navigator cannot under any circumstances read the deliverances of a chart which he himself has not made.† For that reason I can get no explanation of the Samoan chart plan published by Dr. Friedlander in the Journal of the Polynesian Society. It was told me that one might read anything in the lines—it depended on how the chart was held and at what point the islands were supposed to be; but what the maker himself had thought about and what he wished to show by the chart no one would ever know.

From Jochem I learned that he had seen in northern Ratak charts of entirely different form and application. I engaged Jochem to send to Jaluit such charts whenever he could procure them or could interest persons living there to obtain specimens of them.

NAVIGATION IN THE MARSHALL GROUP.

The Marshall Islanders are born sailors, as the position of their islands would occasion, and always pushed the art of navigation extensively. Longer journeys were specially undertaken in the Ralik chain, since its atolls and islands all belonged to the royal family, and for that reason kept up a livelier commerce with one another. Only war expeditions were sailed from the Ralik to the Ratak chain.

In the Ratak chain navigation from atoll to atoll is not so lively, since there a common possession, as in the Ralik chain, does not exist. On most of the atolls, in fact, two kings of different race are in power, who are at war, and therefore it is not safe to go there. For the first time, and in recent years, since they are under the German protectorate and peace prevails everywhere, have they changed their relations. Only in the north of the Ratak chain several atolls belong to a people under Chief Muridjil, on whose part the practice exists of undertaking longer journeys, as has already been said.

To estimate the performance of the navigator, it must be recalled that his voyage never extends over the entire Marshall group, but is always sailed from one atoll to the one lying nearest. The distances from one atoll to another are, as the charts make plain, of no great extent, the longest in the Ralik chain being that between Jaluit and Ebon, 85 nautical miles; the distance from the Ralik to the Ratak chain, between Jaluit and Mille, covers about 120 nautical miles.

As has been shown in describing the charts, the navigator directs his attention in the first place to the dunungs. Whether the stars also were consulted I have not been able to settle definitely. The chiefs denied this, and replied to my questions that they did not specially use the stars, but could just as well find their way when the sky was covered as when the stars were out. On the other hand, Mr. Capelle declared that some old chiefs could direct their courses by the stars, and mentioned as an example that when he was once sailing on an American schooner from Jaluit to Ebon, in company with a chief, the latter remarked to him at night that they were not on the right course, since Ebon lay under a star further eastward. Next morning I found out that he had been right, since they had been standing west from Ebon.

The different dunungs are to be clearly made out by people versed in such things, from the canoes when the water is quiet, and they sail at no other times. As a rule, navigation begins at the close of June or about the first of July, and ends when the trades set in, so that the sailing period on the whole covers about four months. During this time, in every case favorable weather is awaited before a voyage is entered upon, and at first they delay until it seems sure, from a well-known sea lore, that the good weather will last for several days.

The month of July was on this account favorable to setting out on a sea voyage, since then the breadfruit begins to ripen and upon all the islands abundance of this is at hand. A supply of provisions could be carried along only under cramped conditions, since the canoes, as a rule, were already so crowded with men that many times scarcely a decimeter was out of the water.

In such voyages generally a whole people took part, under guidance of their chief. Only entire flotillas and never single canoes take long voyages. The large canoes, which now, since the introduction of the schooners of European pattern, are no longer to be seen, were 50 to 60 feet long and held 40 to 50 persons. Smaller canoes for 10 to 15 persons, which yet exist in larger numbers, and as a rule serve only for commerce inside the lagoons, were frequently taken along.

The canoes consist of the hull, which is made up of large pieces of breadfruit wood sewed together, and the outrigger. Between these is a large platform on which men pass their time. The larger canoes have upon the platform a small hut for covering provisions and mats, and to serve in sickness. In other parts of the canoe nothing was stowed, since this must be always unoccupied. On the starboard, upon the platform, were to be seen large hoods, in two parts, made from mats, for protecting the sails.

The sails, which were of finer mats, were well cared for. When out to sea, if there came a Böe, or a rainstorm, the sail was at once taken down and covered with mats. The reason for thus protecting them must be the fact that the relatively very large sail in a wet condition would become too heavy. The mats are woven from pandanus; the cordage is all made from cocoa palm fiber.

When the trades set in and the sea rises so that the low, full-packed canoes can no longer sail, the dunungs and the kabbelungen were no longer perceivable, navigation ceased, and the canoes were drawn up and entirely overhauled. They were taken apart to renew the joints where the parts came together; the work was polished down with coral, the cordage set right, and new sails prepared.

A flotilla consisted usually of 25 to 30 canoes; there have been some containing as high as 80. The conducting of such a flotilla devolved on the chief and those subchiefs (Leotagetags) who had been initiated into the secrets of navigation. It was strongly and religiously forbidden to divulge anything concerning this art to the people; the chiefs wished to hold this knowledge for their sole benefit, partly for the elevation of their functions, partly to hinder their subjects from learning it in order to free themselves from the frequently tyrannical government of their chiefs.

The chiefs in piloting as a rule stayed together on one canoe, the pilot boat, the other canoes following this. Within the atoll I once saw in the lagoon of ajuro and twice in the lagoon of Arno whole flotillas sailing, when the chiefs there with their following were ordered to appear by His Majesty's ship "Bussard" and to give up their weapons, and they came, moving in close order. The sight was a beautiful one, and the management of the canoes made a fine impression for seamanship. The craft followed in single file and appeared to be used to maneuvering, since the slower ones, as among our own boats of the same size, in order to equal the speed of the superior canoes, took their paddles so as not to be left behind. Captain Kessler is reported to have heard that the canoes on their long journeys sailed abreast in order to reach their destination in better form, but this has not been confirmed, although it may have been practicable. From the explanations received by me, the canoes always followed their leader in single file. The chiefs on the pilot boat act as watch, one on the stern, one on the bow to inspect the water. The latter was the principal officer. In order to be sure that he was on the outlook and kept his eye on the water indications he had to sing continuously. His highest art would consist in keeping on the okar, between the Rilib and the Kælib, or between the Bungdockerik and Bungdockeing. If he got away from the okar, he had from the well-known marks to find it again. That an extraordinary talent for observation and also great discipline was necessary for this goes without saying. That it was possible to the chiefs I must believe from the explanations given to me, which were always the same. I have had a series of journeys between various islands pointed out to me, but always got the same directions.

That the dunungs and the kabbelungs in quiet water are very remarkable in the Marshall group, I have convinced myself; but the statement of the chiefs that the kabbelungs arising near two neighboring atolls run into each other in such a manner that a canoe, by following the boots of one atoll, must come to the boots of the other, are assertions yet lacking in clearness, and they are difficult to put in form.

So, it is not quite conceivable that one may know when he has gotten out of the okar, eastward or westward, or likewise northward or southward, whether in the first case the Rilib or Bungdockeing, or in the second case the Kaelib or Bungdockerik, is perceptibly the preponderating phenomenon. I have long positively refused to admit this possibility, but must agree in the presence of universally expressed opinions. Joachim de Brun told me that at first he had not believed in these appearances in the water, but on a cruise which he had shared his attention had been

*Captain Winkler uses the word Dünung (plural Dünungen) for the special water conditions noticed by the chiefs. As there is no English equivalent I have anglicized the term and will use dunung and dunungs as equivalents. These dunungs evidently mean the great swells as they adapt themselves to the configuration of the islands. Dr. Bastian suggests that the rippling of the water on the side of the canoe assists in the interpretation.—Translator.

†Capt. Joshua Slocum, who circumnavigated the globe alone in his little sloop, the "Spray," furnishes the following account of the "dunungen" and the charts:

"The Marshall Islands charts that I have seen consist of a frame of wood with strings stretched across from side to side. The strings, I understood, represent, one set, the mean direction of the trade wind, and the other set the waves or swells at right angles to the wind. Shells strung at various crossings represent islands, vaguely, in position of the lands known to have been reached by canoe, sailing in certain angles across the wind and waves or swells. During the season of the year when the trade winds sweep over the islands, it requires only the natural skill of a seaman to navigate in this way from one archipelago to another. And even if the direction of the trades varies considerably, the savage islanders know, by natural signs, when they do so, and how much to allow for the variation, as well as do the birds that come home to roost. It goes well with the canoemen usually if they are favored by a clear run, but a little dead reckoning or beating about confuses them.

"I rescued a part of Gilbert Islanders some years ago. They had maps on a small scale and quite useless, translated, I should say, from Morse's Geography. On their charts their country was called Buckaroovoo, and Japan was Taiban. A thunder storm had driven them out of their course and they did not seem to know how to recover the lost ground by clawing to windward, so they were drifting hopelessly about the ocean, 600 miles out of their course, when my ship ran onto them and was instrumental in their return to Buckaroovoo.

"In the matter of the sixth sense, which folk-sailors seem to possess, I am reminded of Captain McKinnon, who thought nothing of a sail through fog without a compass, from port to port, depending on the direction of the wind for his courses. The wind's direction he judged by the density of the fog. He said that the compass bothered him, and as for charts, he carried them all in his head."—Note to the Translator.

*Dr. A. Bastian reports that the first of these charts was received by the Berlin Museum in 1888 from Dr. Finsch, the second from Count Hernsheim, in Jaluit, in 1884. In addition Captain Schück, of Hamburg, has made sketches of all known specimens. Dr. A. B. Meyer reports a specimen in Dresden Museum.—Translator.

†This acute observation is worthy of notice by every ethnologist. For example, the hundreds of totem posts and other complex ethnological carvings in Alaska, the painted robes of the Plains Indians, and the sacred dolls of the Pueblo tribes can be interpreted only by those who make them. It is absolute folly to attempt to explain them without this.

called by the chiefs, and how he himself had witnessed, that the differences could be clearly observed. Probably also, for the art of navigation here described, many other local phenomena are at hand, closely associated with the peculiar situation of this thickly set island region.

My doubts in the beginning, whether such a variety of signs could altogether be taken into consideration, and my opinion that very probably the chiefs had made the Rilibs with the help of the heavens the ground of their courses pursued, were opposed by the charts themselves, with their many lines and symbols, which would be entirely unnecessary. The existence of the charts, the fixed meaning of the lines on them, prove quite conclusively that the water phenomena noted on them must have been used in navigation.

If the course be lost, and the dunungs are not recognized so that the okar can be found again, the chiefs then try to make the islands by means of the Rolok, perhaps, or Nit-in-kot, or Jur-in-okme, and if all these efforts fail the case is desperate. In the northern part of the archipelago the struggle would be to keep inside the group, in order somewhere to strike another island, and this generally succeeded in the southern part, on a voyage between Jaluit, Ebon, and Namorik; the boots were, under unfavorable conditions, entirely obliterated, of which some examples will be given at the close.

It was much easier to keep in the right course sailing with a favorable wind than against the wind. As an example of this the voyage from Jaluit to Mille was cited. As a ground therefor it was insisted that north of the okar from Jaluit to Mille the Rilib is much stronger than the Bungdockerik, southward the Bungdockerik is stronger than the Rilib. On this route it was not the Bungdockerik and Bungdockeing that were taken together into consideration, but the Bungdockerik and the Rilib, since in this region the Bungdockeing is scarcely perceptible. The Bungdockerik and the Rilib, on the contrary, are sharply marked, the first running from southeast to northwest, the other east-northeast to west-southwest, so that they run one upon the other nearly at right angles, a thing which is very apparent to the eye.

In crossing over from Jaluit, the navigator lies first on the starboard bow till the Bungdockerik is much stronger, then he turns and lies on the port bow until the Rilib is the stronger. He need not be so observant that he stay immediately between them, and should be able in his crossing to mark the greater strength of the one or the other dunung, since they run against the canoe forward, entirely distinct and much more striking than when he is sailing with the wind abaft and on a straight course.

The navigator at first makes extended tacks, perhaps six hours long, then gradually shorter. When he arrives at a distance of about 25 nautical miles from Mille, he traces his way by the crossing of the Rolok and the Nit-in-kot, till in the Djelladai (that is, by means of the palm trees) the island comes into view.

The capability of the navigator, his skill in observing the water and drawing the right conclusions therefrom come into play, especially under unfavorable conditions, when good weather fails and the flotilla is surprised by bad weather. As a good example in this line, I was told that a chief on the voyage with his flotilla from Ebon to Namorik encountered so much bad weather, and for that reason had so often to lower sail, that he occupied eight days in the passage. That he did this in spite of the equatorial current, running here from 30 to 40 nautical miles in twenty-four hours and frequently much stronger, must certainly be confessed to have been a great accomplishment.

The journey is not in all cases successful, and there are several sad misfortunes to record. First, from the testimony of Europeans, such cases have been quite numerous, but on close inquiry they cannot be substantiated, so I shall close with enumerating the actual instances recounted by Capelle and those mentioned in the oral traditions of the chiefs, which I have reduced to five:

1. About 1830, a flotilla of over 100 canoes set out on a voyage. It was destroyed, and only one boat, with the chief's daughter, Ligiberik, on board, drove on an island in the ocean; the others were never heard from.

2. About 1855, five canoes would pass from Ebon to Jaluit, but they were wrecked on Kusaie; these came back.

3. At the close of 1860, Chief Larjojak, with 35 canoes, set out from Jaluit to Killi, designing to sail farther, from Killi to Namorik. Nothing was again seen of this flotilla. Light winds were blowing when they left Killi; after that it was stormy.

4. In October, 1860, Chief Jurmella, brother of Lojak, endeavored to go from Majuro to Jaluit with 22 canoes. Of these, one canoe with Chief Lamedo on board was driven near Panope in the Carolines; the rest were never heard from.

5. In 1885, 10 canoes, with a war party of 150 men, under Chiefs Langeo and Leilik set out from Majuro to Aurh; nothing more was ever seen of them.

The loss of single boats has been more frequent. This has happened when a canoe in the night has strayed from the pilot boat and afterward was betrayed and sold, or when single families would desert their kindred and go off alone from the island. But there were never any persons of importance in these canoes.

AMERICAN LOCOMOTIVES IN ENGLAND.—III.

By A LOCOMOTIVE ENGINEER.

I HAVE already dealt with the questions arising from the higher consumption of fuel and the greater expenditure of oil by the American locomotives on the Midland Railway, as compared with their British competitors. I now proceed to a consideration of the points raised by their 60 per cent higher cost for repairs.

What the precise character of the repairs was does not appear from the particulars communicated to the press. But as the engines have been at work even now for something under two years, the repairs in question could not have been of the nature of renewals, as understood in locomotive parlance, but must have been limited to what are known as running-shed repairs. These are confined in the early period of an engine's existence, and provided its bearing surfaces are ample and of the right material, for the most part to letting together the connecting-rod brasses, lining the coupling-rod bushes, and occasionally setting up a bearing spring or two if need be. A few other odd jobs, requiring no great expenditure of time or money, have also to be done, such as replacing fire-bars, the tightening up of leaky tubes, etc., which need not be enumerated in detail. But the chief individual expense is in keeping the bearings right, especially if the axle-box bearings give trouble, because this means much time expended in lifting the engine—necessitating the disconnecting and reconnecting of various parts—in addition to the actual cost of skilled labor in refitting the brasses.

It is difficult to determine the exact proportions of the two classes of repairs named above—the adjustment of bearings as distinct from the other running-shed repairs—without seeing the actual repair sheets. I will, however, put the cost of the former at 50 per cent of the whole. If, therefore, the 60 per cent extra cost of repairing the American engines, as found by the Midland Railway Company, was wholly due to extra upkeep of the bearings, it would mean that this part of the repairs was more than double for the American engines what it was for their British competitors. But part of the extra expense would doubtless arise from more frequent replacement of fire-bars, in proportion, say, to the extra amount of the coal burnt by the American engines; but the cost of the extra fire-bars would not be much. If much of the extra 60 per cent went in the more frequent setting up of bearing springs, away go the claims one so often hears made for the American engine that it is much more easy-running than the British engine on its springs, and consequently on the permanent way. If, on the other hand, any material part of the extra expense was for tightening up leaky tubes, or other parts of the boilers, it would mean so much discredit to the design or workmanship of the American boilers. The defenders of the American engines can have it whichever way they prefer. But, until it is shown to the contrary, I think we may safely take at least 50 per cent out of the total of 60 per cent extra cost of the American engines to be for upkeep of the bearings, which means just double that of the British engines.

Double cost in the upkeep of bearings and brasses means either insufficiency of bearing surfaces or the use of inferior materials, or both; or, on the other hand, it means that the engines are not built fair and square, and that heating and cutting of the bearings result therefrom, necessitating their frequent re-adjustment. But whatever the exact cause or causes of heating or wear of bearings may be, such a condition of things is entirely in keeping with the greater consumption of oil by the American engines, and seems fully to explain what at first sight may have seemed inexplicable. To put the matter tersely, I may say that if the oil bill had been low while the repair bill was high, or vice versa, that which is shown by the carefully-kept records of the Midland Railway to be in harmony the one with the other would have been contradictory. But I would go beyond this, and say that if the American engines had not been shown by the Midland Railway trials to be much more costly in the matter of repairs than the British engines, it would have been contradictory to almost the universal experience of those who have had to do with the working and upkeep of the two classes of engines.

Need we be surprised, however, to find that this is so in view of what is claimed by the advocates of the American locomotive, namely, that as regards both design and make, it is essentially different from the British locomotive, in being not designed or constructed with a view to durability and economy in working or upkeep. That, in short, it is made rather with a view to its having a short life than a long one, the American locomotive maker's contention being, as we are told, "That by the time it is done for and worn out something better will have come along." No words could better express my meaning than this pithy phrase of the chairman of the Midland Railway, so enthusiastically quoted by Mr. Rous-Marten in support of his view that it is open to argument whether an engine life, "artificially lengthened"—as he expresses it—is "really advantageous to its owners." With Mr. Rous-Marten's novel views on this point I shall presently deal; but before passing on I would just add, in reference to the chairman's above-quoted remarks, as to the short life of American locomotives, that, in view of this, it is not to be wondered at his saying to the Daily Mail representative: "Ours are better, and, under all the circumstances, there is no market on English railways for American engines"—a conclusion which I can well believe would be found to be not confined to the Midland Railway Company if the result of the experience of the other English railway companies who have tried American engines were equally candidly made public. I will deal in due course with the remarks of the Midland chairman in reference to the relative merits of English and American engines abroad.

But let us first see how the practice in America of making "cheap" and non-durable engines, in contradistinction to the British practice of making engines "as good as possible to start with," works out from the point of view of the pocket of the purchaser. In the instance in question the American method followed by the Baldwin and Schenectady companies enabled them to deliver their engines on the Midland Railway at about £400 each less than the price of the British-made engines. It was represented at the time by the pro-American press, and too readily accepted by many in this country, that this lower price was for a like article in each case. But this is now known to have been an entire fiction—like many other fictions about American engines abroad of which one reads in the American press, and to which even railway men in this country—I am glad to say non-technical railway men—too readily give credence, but which, like other apocryphal stories, are found to have no foundation in fact when opportunities for testing them, like that on the Midland Railway, present themselves.

But to resume. What has been the pecuniary gain to the Midland Railway Company by the purchase of these American engines at £400 each less than their British competitors—I mean, apart from the primary object for which they were purchased, namely, to meet an unexpected boom of traffic, when locomotive makers in this country were too full of orders to meet the demand for engines? What is Mr. Johnson's opinion on this point? "It would not take long to run away with the £400 in these ways," i. e., in extra coal, oil, and repairs. So said this well-qualified authority to the representative of the Daily Mail. But, after all, it is a very mild way of putting it, as will be seen on going a little more fully into details. It is not easy, I know, to hit upon exact figures in a question of this kind unless one is in possession of the actual running-sheets; but I will take round figures, which I believe to be not far from the mark, as the basis of an estimate of the yearly extra cost of the American engines under the above three items. Anyone whose knowledge of the actual figures enables him to correct my estimate in accordance with fact can readily do so.

For the purpose of my calculations, I will assume the following round figures: A train mileage of 25,000 miles per engine per annum; 55 pounds of coal consumed per train mile in running coal trains; 10s. a ton as the price of the fuel delivered to the engine; one farthing per train mile as the cost of oil; and, lastly, 2½d. per train mile as the average cost of repairs. These are the assumed figures for the British engines. I will work them out into £ s. d. under the several items, then add the various percentages of extra cost for the American engines, as published by the Midland Railway Company, and it will be at once seen how the two makes of engines compare with one another.

But before proceeding with the calculations, I would explain on what basis I assume the foregoing figures. They are based on averages obtained from the official returns of the railways of the United Kingdom. The average train mileage per engine per annum for the whole of the locomotives of the railways in this country is close upon 20,000 miles. In taking the mileage for the engines use in the trials at 25,000 per annum it may be thought by some that I am putting it at too high a figure. I do not think so, in view of the class of traffic on which such engines are employed. On the contrary, I feel that I run the risk of being criticized by our pro-American friends as taking too low a train mileage, on the ground that American engines, at all events, are made for hard service and a big annual mileage, "giving them no rest until they die," as the chairman of the Midland Railway expressed it. In any case, it will be easy, as I have said, for anyone who may dissent from my figures to correct them to his liking. As regards the consumption of coal per train mile, which I put at 55 pounds, the official returns do not keep distinct the fuel used by passenger engines from that used by engines employed in working the much heavier goods traffic. The returns, however, show that for such lines as the Midland and others having about half-and-half passenger and goods traffic, the average consumption of coal per train mile is 45 pounds. They further show that on lines with a relatively large mineral traffic, it averages considerably more than this, while on lines with a large proportion of passenger traffic, like those in the south, it averages not more than from 30 to 40 pounds per train mile. I think I am not far out, therefore, in taking 55 pounds of coal as the average train-mile consumption of the British-made engines used on the Midland Railway in working the goods and mineral traffic on which the engines in question are employed.

Next, as regards the price I have assumed for the coal—10s. per ton—this is doubtless higher than the average price paid by the Midland Railway Company for coal in normal times, although I venture to say that it is a good deal less than it has been paying during the two years in which the American engines have been at work. In any case, 10s. per ton is the average price paid for locomotive engine coal by the railways of England one with another in normal times, and may therefore be taken as a fair basis in a calculation dealing with "American locomotives in England." As regards oil, the average cost per train-mile for the railways in this country, under the heading of "oil, tallow, and other stores," which means small stores, such as gage-glasses, waste for cleaning the engines, and a few odds and ends, is a little under one halfpenny. The cost of the oil will be about one-third of a penny per train mile. I am therefore well within the mark in putting it as low as one farthing, and in any case it is, as I have said, not an important item in itself one way or the other. Lastly, and more important, is the amount of 2½d. per train mile, on which I propose to base my estimate of the relative cost for repairs of the British and American engines. The official returns show that the average cost per train-mile for locomotive repairs for the railways in this country, taking one year with another, is about 2¾d. per mile. In taking 2½d. per train mile, as I propose doing, I am again, I think, well within the mark. Having, however, given chapter and verse for the figures I have taken, it will be easy for anyone to correct them who has inclination to do so if I am wrong.

But to proceed: 25,000 miles per annum at 55 pounds of coal to the mile equals in round figures 600 tons, which, at 10s. per ton, amounts to £300 per annum; 25 per cent on this is £75, and 30 per cent is roughly £90. The mean of these two amounts is, in round figures, £82, which represents the annual extra cost of coal used by American engines—at the assumed price of 10s. per ton—as compared with British engines in doing the same work, as based on the Midland Railway Company's experience.

Next, as to oil, the above-named train mileage at ¼d. per mile works out to £26, and 50 per cent on this is £13, which represents the annual extra cost of oil used by the American engines.

Finally, as to repairs, 25,000 miles at 2½d. per mile works out as nearly as possible to £260, and 60 per cent on this is £156, which represents the annual extra cost of repairs to American engines as compared with British engines of equal power, without placing anything to the debit side of the account in respect of the lessened earning power of the engine by its being longer in the repairing shop.

If the three above-named amounts be added together they give a total of £250 as the extra cost per annum for the working of American engines as compared with English engines. Assuming this to go on for eight

years, during which short time we may, perhaps, reasonably assume even American engines to last before being in a condition to be superseded by "something better"—to use the Midland chairman's expression—we have a total of 250 × 8 = £2,000 to the debit side of the account for working American engines in excess of that for British engines, or, in other words, the former will have been found not only to have swallowed up the £400 representing their less first cost, but to have "eaten their very heads off." If eight years be considered too short a period to assume as the life of an American engine, and ten years are preferred by Mr. Rous-Marten or any pro-American advocate, then so much the worse for the pocket of the owner of the American engine, which in ten years will have swallowed up £2,500 more than its British competitor. Mr. Johnson was therefore indulging in no exaggeration of language when he said, "It would not take long to run away with the £400."

This view of the situation can hardly be satisfactory, I should imagine, to either the owners or the makers of the American engines in question. As regards the items of coal and oil, it is not easy to see how the latter can gainsay my figures, in view of the Midland Railway Company's careful trials. As regards the item of repairs, it is open to them to contend that an American engine is not designed or constructed with a view to its being "tended carefully, and rested, and cleaned out, and everything done to make it last," as is the practice with engines in this country, so well expressed by the chairman of the Midland Railway. On the contrary, that it is "cheaply" constructed with a view to "working it right out till it dies," so as to supersede it with "something better"—I would here suggest a British-made engine, if I may be pardoned for doing so—and that to spend more on its upkeep than is absolutely necessary to "keep it on its legs" during the short period of its existence is money injudiciously applied.

Let us see how the problem works out from this point of view. I do not know what American locomotive men regard as a reasonable annual expenditure in keeping on its legs an American engine, such as those imported by the Midland and other English railway companies, in running 25,000 train miles a year. My own experience of locomotive working leads me to the conclusion that engines which begin by requiring an expenditure of 60 per cent more in upkeep than their British competitors are not likely to require less as they grow older, in preventing them from becoming even more wasteful in coal and oil. Nor do I know what American locomotive men regard as the length of life of an American engine under such circumstances. But, for the sake of argument, let me put the former at as low as one-half the average sum spent on English engines annually in their upkeep in running, say, 25,000 train miles, or £130.

Next, let us assume the American engine to last eight years—a good life for a half-maintained engine—and let us further assume the price of the American engines to be £2,000 each, delivered in this country, although I am of opinion they cost a good deal more than this. It will be seen that an annual sum of (2,000 ÷ 8) £250—less the scrap value of the engine—must be put aside as a sinking fund, to defray the cost of a new engine, in lieu of each American engine "scrapped." This, be it noted, is in addition to the annual cost of keeping the engine on its legs during the eight years of its existence, besides its annual extra expenditure of £82 for coal and £13 for oil. I fail, therefore, to see wherein economy in locomotive working is to be achieved by Mr. Rous-Marten's suggestions in this direction. In fact, I feel that it borders too closely on the *reductio ad absurdum* to be quite suitable for the pages of The Engineer, but when such arguments as I have been dealing with are put forward in its pages by Mr. Rous-Marten as an all-sufficient answer to the proved poorer workmanship and wastefulness of American locomotives, and in disparagement, as I understand him, of objects and methods pursued by locomotive builders in this country, I feel bound, "in the interests of truth, justice, and science"—to quote his own words—to call into question the *rationale* of his arguments.

I do not wish to do Mr. Rous-Marten any injustice. I will, therefore, quote the actual words of his argument: "Which plan embodies the wiser policy?—i. e., the British or the American. It is no doubt an attractive method to make engines as good as possible to start with, and then to tend them most carefully, and do everything to make them last. But it is at least open to argument whether a life thus artificially lengthened be really advantageous to its owners." And why? Let Mr. Rous-Marten make reply: "May it not imply the crowding of a line with ancient locomotives which, while seemingly too good to break up, nevertheless are unable to take standard train loads, and which consequently necessitate either the use of pilot engines or the running of additional trains?" Will Mr. Rous-Marten pardon me for saying, as a rather long-experienced railway man, that I have never met with a prior instance in which so many invalid assumptions in connection with railway working were concentrated in so short a paragraph? They embrace traffic considerations—frequently of trains, for example—as well as locomotive questions. I will confine myself to the latter, and in a few brief sentences. But, before doing so, let me preface by saying that I do not question for one moment that there may be trunk lines in some new and undeveloped countries where cheapness in first cost of locomotives and rolling stock, and railway appointments generally, is of the utmost consequence, and the cost of working a secondary one, and where it would be injudicious to spend more money than can be helped in the upkeep of engines which will, in all probability, be inadequate to the requirements of a more fully-developed traffic at no very distant date, while at the same time few branch lines with their lighter traffic will have come into being. What I maintain is that such considerations are futile in discussing the subject on which Mr. Rous-Marten's article was avowedly written, namely, "American Locomotives in England," and with which I am at present concerned, although I will deal later on, as I have said, with the question of British and American locomotives abroad.

Let me close for the present by pointing out to Mr. Rous-Marten: First, that there *are* branch lines to English railways—and not a few trains running daily on even the main lines—for which the older and less powerful engines are admirably suited. Secondly, that these said engines often come in very handy as pilot engines when the use of two powerful engines would be wasteful. Thirdly, and lastly, that he has entirely omitted to explain why—on his assumption that British-made engines are too well-made, and are therefore liable to last too long—it should be more distressing to the directors of a railway company to "scrap," when no longer required, an engine in good condition, than an engine of the American sort in bad condition, if the keeping of the former in good order has, during its prolonged life of, say, fifteen years—as a consequence of its better original quality—saved the railway company more than one and a-half times the original cost of the inferior American engine. Will Mr. Rous-Marten enlighten us on this point?—The Engineer.

WIRE ROPE-DRIVEN TREBLE RAM PUMP.

In the accompanying engravings we illustrate the latest design of triple ram pump made by Joseph Evans & Sons, of Wolverhampton. It is intended for high lift work in mines, etc., and is arranged to be driven direct by wire rope. Above is shown the whole pump; Fig. 1 is a section through the valve boxes; and Fig. 2 a section of the rope wheel. As will be seen, this rope wheel is not of the ordinary grooved type, but is fitted with a tread, and the driving rope goes round the rim one and a half times. The pump is rated to deliver 18,000 gallons of water per hour against a head of 750 feet.

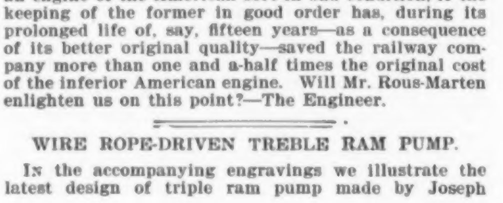


Fig. 1—VALVE BOXES

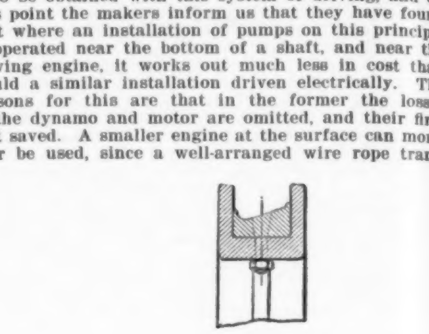
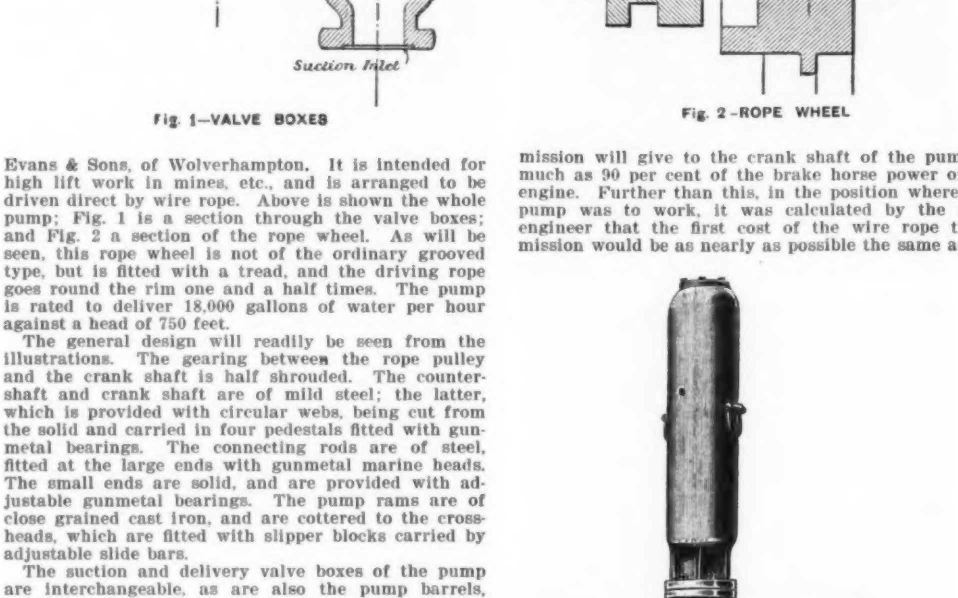


Fig. 2—ROPE WHEEL

The general design will readily be seen from the illustrations. The gearing between the rope pulley and the crank shaft is half shrouded. The countershaft and crank shaft are of mild steel; the latter, which is provided with circular webs, being cut from the solid and carried in four pedestals fitted with gunmetal bearings. The connecting rods are of steel, fitted at the large ends with gunmetal marine heads. The small ends are solid, and are provided with adjustable gunmetal bearings. The pump rams are of close grained cast iron, and are cottered to the crossheads, which are fitted with slipper blocks carried by adjustable slide bars.

The suction and delivery valve boxes of the pump are interchangeable, as are also the pump barrels, without an unnecessary number of joints, and the stuffing-boxes and glands are bushed with gunmetal. The pump valves, which, as will be seen, are of the double-beat type, are also of gunmetal, and an air vessel is also provided. The whole plant is mounted on cast iron girders forming the bed-plate. We understand that this form of bed-plate has been found the most suitable for conveying to the destination in mines.

It will doubtless be inquired what ratio of efficiency is to be obtained with this system of driving, and on this point the makers inform us that they have found that where an installation of pumps on this principle is operated near the bottom of a shaft, and near the driving engine, it works out much less in cost than would a similar installation driven electrically. The reasons for this are that in the former the losses of the dynamo and motor are omitted, and their first cost saved. A smaller engine at the surface can moreover be used, since a well-arranged wire rope transmission will give to the crank shaft of the pump as much as 90 per cent of the brake horse power of the engine. Further than this, in the position where this pump was to work, it was calculated by the mine engineer that the first cost of the wire rope transmission would be as nearly as possible the same as the



ROPE-DRIVEN PUMP.

electric cable switchboard, appliances, etc. The net result, therefore, was that a smaller engine could be used, and the dyamo and motor omitted, while the cost of the transmission system was the same as compared with an electrical installation. In the particular instance of this pump we are informed that a comparison of the two systems showed an estimated saving of nearly 50 per cent in first cost, and an ultimate saving of 25 per cent in the subsequent working cost of the rope-driven arrangement as compared with an electrically-driven plant on the same duty. Of course, if the work of pumping is required to be done at some considerable distance from the source of power, the advantage becomes much more in favor of electricity, because of the upkeep of the rope, and the losses in it. As a fact, however, the cost of upkeep of electric cables in mines is very high.

Joseph Evans & Sons inform us that they have supplied a large number of these pumps for various duties, with heads varying from 600 feet to 1,700 feet, for both mines and water-works.—We are indebted to the London Engineer for the engravings and description.

THE "MONOTYPE" COMPOSING MACHINE.

Like all industries, modern typography is endeavoring to simplify hand labor, and numerous tentatives have been made with a view to substituting mechanical for manual typographical composition.

Our readers have already had presented to them descriptions of the "Calendolé" and "Linotype" machines, the latter of which appears to be the one most generally employed at present.

The Exposition of 1900, especially the American section, presented a certain number of these machines, all very ingenious, but differing in essential points. The linotype, for example, in measure as the composing is done, casts not the separate character but the entire line, according to determinate justification. There results from this a certain difficulty with regard to corrections, since a letter can be changed only by recasting the whole line.

In the Calendolé machine the characters are cast separately and are put by hand into the special cases of the machine. The composition, done by means of a keyboard, then brings the characters automatically alongside of each other.

We now come to a third kind of machine, the "Monotype" (Fig. 1), in which each character is cast separately and immediately arranges itself in its place in order to form a line. Contrary to what generally occurs in other apparatus, the compositor does not have to occupy himself with the latter, but operates upon another machine that serves to prepare the work. This machine, which is entirely separate (Fig. 2), comprises a very complete keyboard that includes all the signs, letters and ciphers that may be needed. At the upper part there is a spool upon which is wound a band of paper, *P*, about 8 inches in width and of indefinite length, which unwinds from another spool placed opposite. In order to pass from one spool to the other the paper traverses a mechanism by which it is perforated with apertures about 8-100 of an inch in diameter, through the action of keys struck upon the keyboard. The apertures thus produced are situated at different points of the width of the band according to the character that they are designed to represent. A table, engraved upon a vertical cylinder, and a divided rule permit of regulating the spaces between the lines, words and letters in advance.

The compositor, having the copy under his eyes, has therefore only to strike upon the keyboard to puncture the band of paper according to the arrangements decided upon. This band is then preserved for ulterior use, if there is no hurry about the printing; or, if the contrary is the case, it is used immediately.

In order to employ it, the spool that carries it is placed upon the composing machine in a special frame, such as is illustrated on a larger scale in Fig. 3. The paper, upon unwinding from the spool, *B*, passes over a stationary cylinder, *A*, with which one of the generatrices is provided, with apertures placed alongside of one another. It is held in this position and closely applied against the apertures by means of a piece, *C*, which turns down, in pivoting around the point, *D*, when the paper is in place. As may be seen, this piece is provided with a groove that corresponds to the holes of the cylinder. It communicates with a reservoir of compressed air. It will be understood, then, that at the moment at which an aperture in the paper presents itself opposite an aperture in the cylinder, *A*, it is possible for the air to pass and actuate the special mechanism which corresponds to such aperture, and which, through quite a complicated play of levers, causes the advance of the matrix that corresponds to the character desired. This matrix presents itself under a crucible in which the type metal is kept in fusion by means of a gas jet, and a drop flows out to form the character. The cooling is almost instantaneous, and the matrix deposits the characters in a channel, *M* (Fig. 1), wherein they form a line.

The corrections are easily made, since the characters are separate. All that is necessary is to replace defective or badly placed letters by type taken from cases as in composing by hand. Electricity might have been employed by utilizing the apertures in the paper for producing contacts and closing a circuit, but the inventor has preferred compressed air.

The machine was operated in the American section upon the Esplanade des Invalides, and the composing was effected very regularly. We have not been able to obtain any details as to the rapidity with which it can be done as compared with manual labor. There is evidently a loss of time between the moment of the composition upon the band and the moment of the production of the typographical line; but the operator has the advantage of being able to recommence the composition as many times as he desires with the same band. When a work that may possibly pass through other editions is printed, a mold is made of the composition in such a way as not to disturb the characters. In case of a new impression it suffices to flow metal into this mold in order immediately to obtain a composition all ready to be printed. But the paper band of the machine might allow the molding to be dispensed with, since it would suffice to preserve it in order very quickly to make another composition in new characters.—For the above details and the accompanying engravings we are indebted to La Nature.

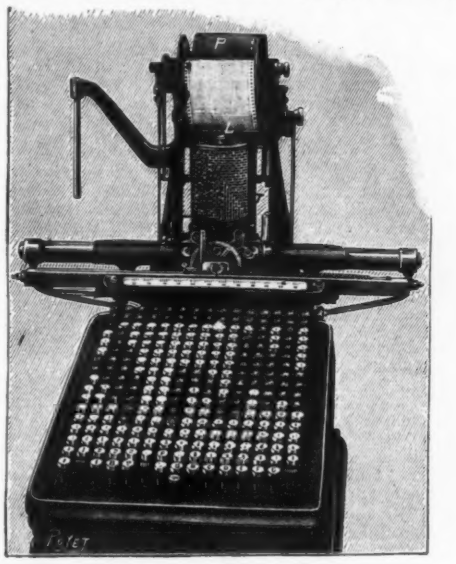


Fig. 2.—KEYBOARD FOR PERFORATING THE PAPER BAND.

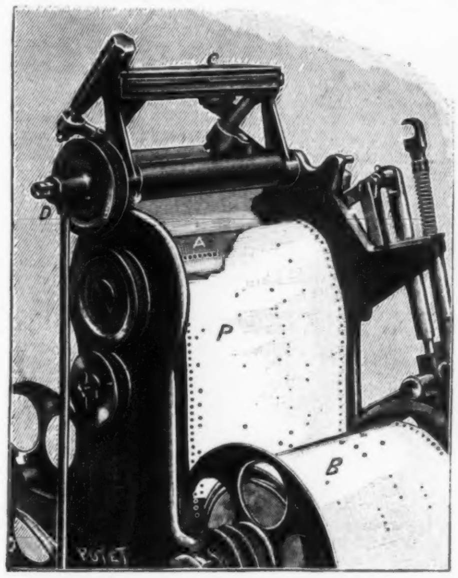


Fig. 3.—PERFORATED BAND EFFECTING THE COMPOSITION AUTOMATICALLY.

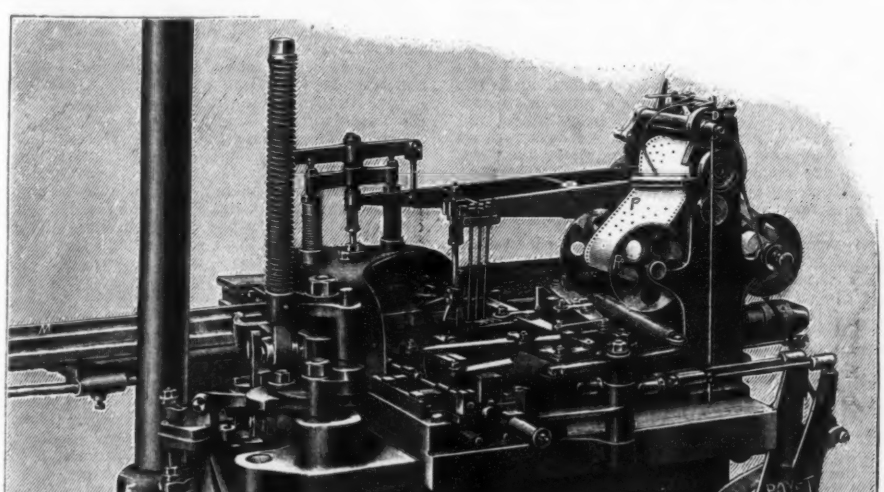


Fig. 1.—WASHINGTON MONOTYPE COMPOSING MACHINE.

CAR LIGHTING BY ACETYLENE GAS.

By H. E. Smith, Chemist, Chicago, Milwaukee & St. Paul Railway.

As is well known, acetylene gas is made by the action of water upon calcium carbide. Very pure materials are required for the production of a good quality of carbide which will, in its turn, produce a good yield of pure gas. The most injurious impurities are sulphur and phosphorus, both of which are liable to occur in the lime or coke and are ultimately found in the gas. In laboratory tests one pound of good commercial carbide will yield 5 cubic feet of gas. It is the experience of the writer, however, that in actual service with commercial generators, there will be some losses due to occasional blowing off, loss of gas in charging and by solution in the water used, and other causes, and that it is safer to assume a yield of only 4 to 4.5 feet per pound.

The gas itself is colorless, lighter than air, and when pure has only a slight and not unpleasant odor. It is condensed to a liquid only by a pressure of several hundred pounds. As made for service in the best commercial generators, it approaches closely to this standard, but the product of the poorer generators is contaminated with ill-smelling impurities and gradually deposits oily and tarry liquids. The choice of a generator is therefore a matter of importance.

Acetylene gas is, in the minds of many persons, still associated with the disastrous explosions which occurred during the early attempts to utilize the liquefied gas. Like all combustible gases, it forms explosive mixtures with air, but as now used, under moderate pressures and temperatures, the unmixed gas is not explosive. Acetylene has suffered at the hands of its over-zealous friends who have made extravagant claims for it, especially in the matter of candle power, which has often been much overstated. Careful tests which have been made show that a fair quality of gas, as produced under the conditions of actual service, will give a light of 33 to 35 candles per cubic foot per hour, when using burners of a capacity of one-half foot or over. If tested under the same conditions, smaller burners, for example, one-fourth foot, do not give quite as much light in proportion to the gas consumed. Acetylene is burned with somewhat higher pressure at the burner than with ordinary coal gas, a pressure of 22 to 25-tenths of an inch of water giving the best results.

A number of methods of utilizing acetylene for car lighting have been proposed. These may be classified, first of all, as compression and car generator methods. In the compression method, the gas is prepared in a stationary generating plant, purified, compressed and carried under pressure in cylinders under the car, in the same manner as Pintsch oil gas. From these cylinders the gas passes through a pressure reducing and regulating valve to the burners, as in the Pintsch system. In one compression system, which has been applied to a considerable number of cars, the car cylinders are charged at 150 pounds pressure. To guard against excessive pressure or dangerous decomposition, should the apparatus become highly heated in wrecks or otherwise, the cylinders are made with rivetted and soldered seams and the pipes of fusible metal. The joints and pipes will then melt and allow the gas to escape quietly before the temperature of decomposition is reached. As to shock, direct experiments by several investigators have shown that at 150 pounds there is no danger of decomposition or explosion.

In another compression system it is proposed to charge the cylinders at only 50 pounds, and use ordinary caulked joints and iron pipe. In this case the gas must be heated to about 1,100 deg. F., before it attains a pressure of 150 pounds. Fusible plugs are provided for relief at high temperatures. Direct experiments have shown that at 50 pounds cylinders may be heated to redness without explosion. Obviously, cylinders will hold only one-third as much gas at 50 as at 150 pounds, and either more storage capacity or more frequent charging will be required.

All compression systems have the disadvantage that cars must periodically return to charging stations. They have several advantages, however. The gas may be made slowly in large stationary generators and be thoroughly purified and dried. The apparatus on the car is of the simplest character and requires no attention from the trainmen except turning the gas on and off, while the labor of cleaning is reduced to the wiping of globes and shades and the occasional cleaning of burners.

A number of designers have brought out automatic generators to be placed directly on the car, to produce gas as needed. Automatic generators have been successfully operated for house lighting for a number of years, but these are not well adapted to car lighting, partly because they require too much space, and partly on account of details of design or construction which are either unsafe or unreliable when subjected to the vibration and shock incident to car service. Generators may be divided into two classes, those in which the water is added, a little at a time, to the carbide, and those in which small portions of carbide are thrown into a considerable volume of water. Obviously it is much simpler and easier to arrange an automatic feed of a liquid than of a solid, even if the latter is in a state of rather fine division. The liquid can be controlled by a balancing of pressures, while for the

solid some form of mechanism is necessary. Water feed generators were, therefore, first brought out.

The action of the water on the carbide is attended with the development of a considerable amount of heat, and the temperature is especially liable to rise in water-feed generators because so little water is present during the action, to absorb the heat. The residue of lime, left by the carbide after the evolution of the gas, is a very poor conductor of heat, a circumstance also favorable to the development of a high local temperature. On opening generators of this type while in operation, we have at times measured differences of temperature as great as 300 deg. within a space of 2 inches. But high temperature at the point of generation is productive of gas which is impure and deficient in candle power. Inventors of water-feed apparatus have therefore endeavored to secure as good regulation of the water as possible, and, in the best generators have attained very good results in this particular. Another method of avoiding heating, which is frequently adopted, is the division of the charge of carbide into small portions, each of which is nearly exhausted before the next is attacked.

The water may be admitted at the top or bottom of the mass of carbide. In one generator which is in successful operation on several roads, the water is admitted at the top from an elevated tank by means of a pipe passing first to the bottom of the apparatus, then turning upward to the top of the carbide holder. The gas passes out at the top of the same holder. This arrangement allows of the desired balance of pressure between the water and the gas. The carbide is divided into portions of 1½ pounds contained in baskets arranged one above the other, in such a manner that only one basket is in action at a time, being fed by the overflow from the next higher basket. The baskets are placed in removable cartridges, and as the generator is made in two units, it may be operated continuously for an indefinite time by changing the cartridge in one unit while the other is working. The generator does not appear to attain a temperature sufficiently high to injure the gas. In another apparatus which has been recently devised the carbide is contained in a seamless steel pot which is partly immersed in a tank of water. The water reaches the carbide through a check valve and small orifice in the bottom of the pot, thus coming in contact first with the bottom of the charge of carbide. This arrangement permits a slow flow of the water, which is stopped by the pressure of the gas when the lights are turned off. The generator is the simplest one now on the market, and admits of cleaning and recharging with a minimum of time and labor.

Carbide feed generators have a large place in house lighting, where they give excellent service and very pure gas. They are less readily adapted to car lighting, however, and have not yet come into extensive use, although one or two designs have been presented which appear to be very well worked out. In generators of this type and of a size adapted to car lighting 1 to 4 ounces of crushed carbide are dropped at a time into 10 to 25 gallons of water. The carbide feeding device is operated in proportion to the consumption of gas and is set in motion by a variety of means, such as the rise and fall of a gas storage bell, or of the water in a displacement tank, or directly by the rise and fall of the gas pressure itself. One maker uses a weight or spring motor which is stopped and started by the rise and fall of a bell. The carbide is contained in a closed hopper, and is discharged therefrom by various devices, such as screw conveyors, sweeps which push the carbide off from a platform, valves of different kinds, or by horizontal or vertical wheels carrying pockets which are filled on one side and empty on the other. It is too early to decide which of these plans is best for a car generator. It is essential, however, that the parts move very freely, and be so arranged that they cannot be clogged by carbide. In generators of this class the charge of water should be one-half to one gallon for each pound of carbide. Less than the smaller amount produces a residue which does not flow out completely, and the generator runs hot. More than the larger quantity requires inconveniently large tanks and causes some waste of gas, for the reason that water will hold in solution its own volume of acetylene.

Generators which are provided with a floating storage bell work at a constant pressure corresponding to the weight of the bell, which is suitably adjusted. In all others the pressure is variable and regulating valves are necessary. Satisfactory valves are readily obtainable which will keep the pressure on the burners at and desired constant amount.

In nearly all cases the gas is moist as it leaves the generator, and as it is most convenient and safe to run the pipes on the outside of the car, the moisture must be removed or the pipes will be stopped by frost in cold weather. This is usually accomplished by passing the gas through cooling coils which drain back to the generator, and through a cylinder under the car, where the remaining moisture is deposited. In one generator we have introduced the modification of passing the gas through fresh carbide which absorbs the moisture very satisfactorily.

The quality of gas furnished by a generator may be readily judged by a few simple observations. The odor should not be strong or exceedingly offensive. The residue should be white or light gray. Yellow, brown or black residue indicates hot generation and inferior gas. Carbide feed generators should not run warmer than 110 deg. F., and water-feed ones not higher than 140 deg.

In judging of generators the following points are important:

1. The generator should be substantially built, with as few joints as possible. Joints should not depend on solder alone. Brass and copper should not enter into the construction to any considerable extent.

2. A reliable automatic blowoff should be provided, which will relieve both over-pressure and over-generation of gas.

3. Generators should be entirely automatic and require no attention from trainmen except turning the gas on and off. When allowed to stand idle but fully charged, or when suddenly shut off while working at full load, the generator should not blow off.

4. The gas should be pure and cool as described above, and sufficiently dry to stand the coldest weather.

5. There should be enough storage capacity to take up all after-generation, and to allow charging and restarting without the extinction of the lights by the air thereby introduced. Suitable cocks, preferably automatic, should be provided to prevent back flow of gas while charging.

6. Gage glasses whose breakage would allow the escape of gas should not be used. Flexible tubing, swing joints, springs, chains, pulleys, stuffing boxes and check valves are undesirable and should not be used where their failure will affect the safety or reliability of the apparatus.

7. Generators should have a carbide capacity of not less than 30 pounds, and an indicator showing at all times how much unused carbide remains.

8. Obviously, simplicity of construction and operation is very desirable.

It is to be remarked that all of the above specifications are not filled by any generator now on the market, although some approach it closely and improvements are constantly being made.

The early progress of acetylene car lighting was hindered by the lack of suitable lamps and fittings. Old oil lamps and Pintsch gas lamps have been re-arranged with fair success. Now, however, at least two makers provide lamps especially designed for acetylene. The lamps should be so arranged that the gas is not heated before reaching the burners, the air supply should pass through without strong currents to cause flickering of the blaze, and the interior should be readily accessible. The arrangement and kind of reflectors, shades and globes are also important. A certain amount of reflection is desirable to avoid waste of light in the upper part of the car, and this may be obtained by white reflectors, as in Pintsch lamps, or by ordinary white opaque shades of suitable outline. Etched or opaque globes cut down the total light radiated but give better distribution. Actual equipment of a car is the most satisfactory method of judging a given arrangement of lamps.

It is yet too early to make reliable estimates of all the items entering into the cost of acetylene lighting, as compared with other systems. The cost of equipment will vary according to circumstances, but the following is believed to be a fair estimate for a 60-foot coach, provided with center, closet and vestibule lamps:

Oil	$253.00
Acetylene	459.70
Storage electricity	841.40
Combined electricity	580.00

In each case the labor of installing is included. For oil lighting six double "Acme" center lamps are provided for the center of the car. This is one more than is ordinarily used, but is still too few to give as much total candle power as is furnished by the other systems. In the estimate for storage batteries is included a proportional amount for the charging station, also for reserve batteries. "Combined electricity" represents a baggage-car dynamo system with a small storage battery auxiliary which supplies a portion of the lamps for a short time during the changing age of locomotives and other interruptions. This system is charged with the proper proportion of the baggage-car plant on the assumption that the train consists of four coaches and the baggage car.

The cost of operating one car for five hours per day for one year is estimated as follows:

	Oil.	Acetylene.	Storage Electric.	Combined Electric.
Interest and depreciation	$27.83	$50.57	$160.79	$74.90
Fuel	55.60	155.48	31.25	31.25
Repairs and supplies	13.00	15.00	20.00	15.00
Attendance	17.00	15.00	35.00	53.32
Total	$113.43	$236.05	$247.04	$174.47

In the combined electric system the attendance charged is the extra pay received by the baggageman for that service. In neither electric system has any charge been made for auxiliary light for use in case of failure of the current. Such auxiliary is frequently but not universally used. Sufficient oil lamps for this purpose would cost about $85, but would add little to the cost of operation. The estimates are based as far as possible on actual practice and records. Obviously many of the items will vary somewhat on different roads, according to variations in the management of details. Thus the cost per car for the combined electric system decreases as the number of cars per train increases. In the storage system the cost of attendance and charging will vary in different places. In a system in which there are principal and auxiliary lights of quite different cost, the total cost will vary considerably, according to the proportion of the time during which the auxiliary light burns.

In comparison with other modern systems of lighting acetylene generated on the car has the advantage of the complete independence of cars of each other and of charging stations. The use of compressed gas or of storage batteries requires the periodical return of cars to charging stations. Electricity from a dynamo in the baggage car necessitates connections between cars, adding to the labor of making and breaking up trains, and also restricts the cars to trains having a dynamo baggage car. When only main line trains are so provided, cars which are set out for branch lines must depend upon auxiliary lights for the remainder of the trip. The dynamo requires some attention, which is easily given by the baggageman on through trains, but not on local trains making frequent stops. A properly arranged acetylene system calls for no attention on the train except lighting and turning off the lights. On one road the acetylene lamps have been provided with electric igniters, thus allowing them to be lighted, even from a distance, merely by the turning of a key, as with electricity. For some special purposes, such as sleeping car berth lights and ventilating fans, the electric current is practically indispensable. The cost for attendance of acetylene lighting is not greater than that of oil lamps, and with some generators may be considerably less.

For solid through-trains acetylene is not better or cheaper than electricity, although it compares favorably with that method of lighting. For suburban and other local trains acetylene is especially adapted. At present there are in this country 82 cars in operation or in process of equipment, five different systems of apparatus being represented.—The Railroad Gazette.

TRADE NOTES AND RECEIPTS.

Production of Blue Sealing Wax.—Melt:

Venice turpentine	1 part
Burgundy pitch	1 part
Dammar resin	2 parts
Shellac	2 parts

together and stir into the molten mass:

Ultramarine	3 parts

—Farben Zeitung.

Substitute for Linseed Oil Varnish.—Goldblum dissolves crushed rosin, with stirring, in a suitable quantity of benzol, benzine or naphtha, e. g., in the proportion of 50 parts of resin to 100 parts of solvent, and treats the solution obtained with coarsely powdered, calcined soda or with another alkaline carbonate, with constant stirrying, whereby the latter, without combining with the rest, causes the impurities of the resin to separate. At the same time, the water which is usually found in the commercial resins is absorbed by the calcined soda and thrown to the bottom. The sediment with the soda in excess is then separated from the liquid.—Der Seifenfabrikant.

Sponges as Filtering Agents for Tinctures and Juices.—In place of the sometimes expensive filtering paper, W. A. Domson recommends the use of ordinary small "table" sponges for tne filtration of large quantities of pharmaceutical preparations. The sponges are cleaned in the customary manner, rolled together as much as possible and placed into the escape pipe of a percolator in such a manner that the larger portion of the sponge is in the pipe while the smaller portion, spreading by itself, protrudes over the pipe toward the interior of the percolator, thus forming a flat filter covering it. After a thorough moistening of the sponge it is said to admit of a very quick and clear filtration of large quantities of tinctures, juices, etc.—Pharmaceutische Zeitung.

Red Lead as an Insulating Material for Electrical Conduits.—In telegraphy the remarkable fact has frequently been observed that many gas pipes do not conduct the galvanic current, thus failing in their capacity as subterranean lines, for which they ought to be well adapted, owing to their extensive ramification through the ground. Another phenomenon which has been observed is that flashes of lightning in buildings will leap off from gas pipes and take other courses to the ground. The fact that the pipes always have sharp corners, that lightning takes the shortest way to the ground, making the most remarkable bounds in its course, was hardly sufficient explanation for this peculiar appearance. "Telegraphendirector" Hackethal, of Hanover, however, thought it probable that the cause might lie in an interruption of the metallic combination of the pipe conduit, hence, possibly, in the joints themselves.

At the occasion of an alteration of the telegraph building at Bremen in 1894 an iron girder painted with red lead, which had been lying for 18 years, was found to be so entirely insulated from the earth that a sensitive galvanometer, even with a pressure of 150 volts, did not show the slightest deflection. This fact, coupled with the appearances observed with the gas conduits, causes Hackethal to suppose that red lead in time and under certain conditions assumes a high degree of insulation-resistance, which was capable in certain cases to bar the way even to electricity of high tension, such as atmospheric discharges.

Experiments have shown that with the aid of red lead a very serviceable, resistive, and weatherproof insulation material may be produced from inferior fibers, which is fit to take the place, in many cases, of gutta-percha and other substances employed for insulating purposes, and particularly to effect the permanent insulation of aerial conductors exposed to the action of the weather. Basing upon these results, Hackethal used for the said insulating purposes vegetable fibers of any kind, which surround in the shape of tissues the conductors to be insulated and are in this form saturated with liquid red lead. The latter is accomplished in the proportion of 4 to 5 parts of red lead (by weight) to 1 part, by weight, of linseed oil, by the hot or cold process, by mere immersion or under pressure.

It is true all the three substances, fiber, oil and red lead, possess in themselves a certain insulating capacity, but none of them is alone of utility for such purposes. Even the red lead mixed with linseed oil does not possess in the liquid state a high degree of insulating power. Only when both substances, the ingredients of the linseed oil capable of absorbing oxygen and the lead oxide rich in oxygen, oxidize in the air, a new gummy product of an insulating capacity of more than 100,000 megohms (1 megohm = 1,000,000 ohms) per cm^3 results, with all the properties favoring its use as insulating agent.

The oxidation process is started and materially accelerated by the liquid red lead, by virtue of its oily nature in the beginning, entering the fine pores of the fibers and hardening in them under the action of the air. The textile fiber thus impregnated thereby completely loses its hygroscopic qualities and gradually acquires the insulating properties peculiar to gum, as well as such permanency and resistance that is in no way disadvantageously affected by moisture, nor by cold or heat, within the utmost limits of the ordinary air temperatures. The same is true of the film-like red lead coating forming on a wire, which likewise gradually acquires the necessary hardness and resistance and assists the insulation effected by the impregnated textile covering. In order to test the behavior of such a wire under the action of acid vapors, a bright bronze wire of 1.5 millimeters and a wire, protected by red lead insulation, of the same thickness were suspended on the 9th of February, 1900, in the yard of a chemical factory near Hanover, in the midst of fumes issuing from hydrochloric acid condensers about 8 meters above the condensers, conditions which are not very likely to occur in practice. While the bright wire had been completely destroyed by the acid vapors on March 12, the insulated wire was found to be still entirely intact on September 12. The foregoing demonstrates that red lead as an insulating agent for electro-technical purposes has a great future before it.—Farben Zeitung.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

High-Speed Electric Traction at Berlin.—Through some misapprehension, there appeared in the American press about three months ago a paragraph in which it was stated that an experimental test of electric trains had been made on a new railway between Berlin and Hamburg, by which a speed of 125 miles an hour had been readily attained. This statement was widely republished, generally as the text of editorial congratulation that the problem of greatly increased speed in railway travel had been so promptly and conclusively settled. From this the deduction was easy and natural that within a few years the present steam railway system would be wholly superseded for passenger traffic by electrical lines. All this was so far from the actual fact, and has inspired such a chorus of vain but insistent inquiry, that it seems due and requisite that a plain, concise statement shall be made of what has been undertaken by the experimenters at Berlin, what has been accomplished, and what yet remains to be done.

For several years past it has been recognized by scientific men in Germany, as elsewhere, that cars driven by electricity, which have practically displaced the horse car as a means of intramural and suburban travel, would sooner or later dispute the supremacy of steam railways for long-distance passenger traffic. The main governing motive for such a transformation would be the greatly increased speed that could thereby be attained. It was felt, however, that the high-speed problem involved many details of construction and practice concerning which comparatively little is known. No careful engineer or capitalist would enter upon the construction of a high-speed railway for actual service until the whole subject had been thoroughly studied and its feasibility proven by practical demonstration. For this purpose there was organized at Berlin, on the 10th of October, 1899, a so-called "Studien Gesellschaft," or "company for experiments," in high-speed traction. This company—which has for its president Dr. Schulz, chief of the imperial railway administration—includes as members the General Electric Company of Berlin, Messrs. Siemens & Halske, the great machine builders, Börsig, Krupp, Halzmann, and Van der Zuypen & Charlier, besides several banks, which undertook to supply the capital of 750,000 marks ($178,500) for the necessary expenses of construction. The mere mention of the foregoing names will show that the Studien Gesellschaft represents the foremost scientific and mechanical ability of Germany. After more than a year of study and experiment with motors, conductors, and especially the task of taking up an electrical circuit by a motor moving at high speed, Director Rathenau, of the General Electric Company, in January of this year, had a formal interview with the German Emperor, in which he submitted a plan for using as an experimental electric line the military railway leading southward from Berlin to Zossen, a distance of 30 kilometers (18.6 miles). The proposition of Mr. Rathenau was promptly and fully approved, and from that moment the whole scheme has had the active support of the Imperial Government. The line to Zossen is now in process of preparation for the trials, which, it is expected, will begin in August or September. For these experiments two motor cars will be, or have been, built—one by the General Electric Company, the other by Messrs. Siemens & Halske. Each will carry about fifty passengers, and efforts will be made to attain a speed of from 125 to 150 miles an hour.

Meanwhile, Messrs. Siemens & Halske have been making some preliminary tests on a short provisional line, which was built for experimental purposes a year or two ago at their works at Lichterfelde, near Berlin. The motive of these preliminary trials has been to test the important, but hitherto undemonstrated, point whether a motor moving at a speed of 100 miles an hour or more will take the current readily from a three-wire line.

It is well known that there are certain electric roads in Switzerland and northern Italy where alternating currents of high potential are used, instead of the 500-volt continuous current which is employed on most city tramway lines. The high voltage is used for the purpose mainly of being transmitted on small wires over long distances from water-power generating plants. It is then reduced by passing through generators—located where the current is wanted—to a voltage considered safe and suitable for working the trains.

In using this three-phase alternating current, it has been found necessary to employ three conductors, viz., two overhead wires and a third rail. The high-speed experiments here will be based on this arrangement, and the provisional line of Messrs. Siemens & Halske has carried a step further the experience already gained by the Swiss and Italian roads at ordinary speeds, and yielded some highly interesting and valuable results.

This, then, is the present status of the enterprise. There is no electrical railway between Berlin and Hamburg, nor will one be seriously thought of until the high-speed experiments on the short line between Berlin and Zossen have demonstrated exactly and conclusively every condition of the problem. These experiments will be undertaken when the line to Zossen is specially prepared and the two motor cars now being built for that purpose are ready. That these preparations are not yet complete is shown by the fact that the Society of British Engineers, which visited Berlin a few days ago as guests of Messrs. Siemens and Halske, saw the provisional three-wire testing installation at Lichterfelde, as well as the motor car built for the coming experiments by the General Electric Company, but were not taken to see the railway to Zossen.

The trials, when they do occur, will attract electricians, machinists, railway managers, and expert scientists from all European countries, and the results, if as successful as is now anticipated, will mark a notable epoch at the beginning of the century. From all that can be learned from the eminent, but very conservative, men who have the enterprise in charge, no insurmountable difficulties have yet been encountered; but, on the other hand, everything thus far done has been merely tentative and preparatory. The real difficulties of the problem have yet to be met.—Frank H. Mason, Consul-General at Berlin.

An American Box Factory in Japan.—Consul Lyon sends from Hiogo, June 14, 1901, a newspaper clipping describing a cigarette-box factory in Kyoto, as follows:

A representative of The Chronicle recently had the opportunity of inspecting the factory of the Oriental Printing Company, Limited, at Kyoto, an enterprise which has been established specially for the making and printing of cigarette boxes. We understand that the capital of this undertaking is two-fifths American and three-fifths Japanese, while the business is carried on entirely on American principles. For example, the check system is adopted in dealing with the workmen's time, and every man must have his check stamped on passing in or out of the works, the stamping being done by a clock which automatically registers the minute the check was placed in the slot.

The Oriental Printing Company has lofty and roomy workshops and machinery of the latest type, mostly imported from America, one or two special machines, however, being from Germany. The machinery is driven by an electric motor, the power for which is derived from a small steam engine fitted on the premises. There are two foreign printers employed and one foreign lithographic artist.

The boards for making cigarette boxes are imported, but the rest of the manufacturing process can be seen at Kyoto, from the coloring and printing of the surface to the finishing of the neat little boxes in which the cigarettes are inclosed. There is printing from aluminium surfaces, lithographic stones, and engraved plates. One machine took in at one end a long strip of printed cardboard and turned it out at the other end a box or case ready for filling. All the processes, however, were interesting, the delicacy and precision of the machines and workmen and the skill shown by the lithograhic artists affording evidence of the perfection to which this industry has been brought.

As we have said, these works are conducted on American lines, and the workmen are evidently under much more strict discipline than is usual in Japanese offices—some of them having had several years' training in a similar establishment in Rochester, N. Y.—and it would be interesting to learn how the methods work in this country. But the establishment of such an undertaking is possibly an indication of the tendency to set up foreign manufacturing enterprises in this country, a tendency that would be much more rapid, to the great advantage of Japan, were it not that the land laws are at present illiberal in denying landholding rights to foreigners.

Metal Workers' School in Saxony.—An exhibit of the work done by pupils of the Metal Workers' School at Rosswein has been recently held in Freiburg, which showed the thoroughness of the instruction. The school has an average of sixty to seventy students. These pupils are chiefly from Prussia and Saxony, but all sections of Germany are represented, and even Sweden and Austria. One of the conditions of admission is that the pupil shall have had three years' practical experience.

Many of the states of Germany are liberally aiding the school and granting free scholarships to worthy young men.

The school is provided with a technical library, reading and reference room, and has a large supply of scientific apparatus, electromotors, batteries, etc., and many practical models of buildings, machines, etc. Excursions are frequently made by the pupils to the large factories and mines of importance in the neighborhood. The course at the school lasts from one and one-half to two years, and embraces four departments—building, fine arts, machines, and electrotechnics.

A great deal of attention is given to drawing. The student is taught to create, and, in order to stimulate the inventive faculties, the German Patent Office sends the institution, free of charge, copies of patents pertaining to mechanical, metal, and electric apparatus.

In addition to the special branches in metal work, etc., attention is also given to physics, chemistry, algebra, geometry, bookkeeping, and German language lessons.

The tuition fee for the semester, or half year, is 100 marks ($23.80) for citizens of the German Empire and 200 marks ($47.60) for foreigners, and an additional fee of 25 marks (foreigners, 50 marks, or $11.90) for the use of apparatus, machines, and material.

The city of Rosswein has about 8,000 inhabitants, and is situated on the main railroad line between Leipzig and Dresden.—E. Theophilus Liefeld, Consul at Freiburg.

Trade Opportunities in the Persian Gulf.—Consul Schumann, of Mainz, June 27, 1901, says that according to a German trade journal the following articles find a ready sale in the ports of the Persian Gulf:

Accordions, needles, photograph albums, matches, gold-plated steel jewelry, tobacco and cigarette cases, music boxes, wax candles, buttons, brushes, table cutlery, calico, canes, whips, shawls and kerchiefs, cement, canned goods, cottons, woolen and cotton blankets, glassware, leather, copper, cloth, blue and red ink, sponges, towels, tin, fans, crockery, artificial flowers, silks, gold lace, gloves, gauze, olive oil, lamps and lanterns, iron bedsteads, eye glasses, sewing machines, furniture, looking-glasses, watches and alarm clocks, handkerchiefs, coffee grinders, writing materials, umbrellas, perfumery, wax, pearls, decorated porcelain, pharmaceutic preparations, ribbons, salt fish, sardines, butter, soap, linen, velvet and velveteen, and wines.

Strikes in British Columbia.—Consul Dudley writes from Vancouver, July 4, 1901:

The difficulties between labor and capital in this Province have paralyzed business to an alarming extent.

The salmon fishermen are on strike, demanding higher prices for the fish. The salmon are now running, and few fishermen are out. In the long run, this may be advantageous to the fishing industry, as a much larger number of fish is likely to reach the spawning grounds than would be the case were the fishermen at work. This may result, some four or five years hence, in a much larger run.

The trackmen of the Canadian Pacific Railway are on strike. The railroad people think that a settlement may be reached at an early date.

At Rossland, all the employes at the Northport smelter are on strike. During the shut-down of last year some 2,000 men left to seek employment elsewhere, chiefly in the United States. If the present trouble is long continued there will again be a similar exodus. Many of the miners are American citizens.

In later reports the Consul says that the fishermen have resumed work; but the recurring troubles with the canners may lead to the establishment of traps to take the place of boats.

The Rossland difficulty is serious. The mines have been shipping 10,000 tons of ore weekly, and if the strike continues business there will be at a standstill.

Loss of United States Trade in Cape Colony.—Consul-General Stowe sends the following from Cape Town, May 28, 1901:

The plague now prevailing in this colony, together with the war (which compels vessels from United States ports to lie in the bay for days at a time before dockage facilities can be obtained), has caused orders for certain goods always obtained in the United States to be sent to England. Street railways supplies, for instance, are ordered there at an excess of freight and cost. Provisions and all other lines needed promptly are now shipped from England. The mail boats sailing from Southampton are allowed to enter the docks on arrival to discharge passengers, and, consequently, are allowed to discharge their freight. This prompt delivery of goods, sixteen to twenty days out from Southampton, is the cause of change of orders. Even if ships could enter the docks on arrival, the discharge would be very slow, on account of the lack of labor, the Kaffirs having become frightened because of the plague.

Under date of June 5, Mr. Stowe says that all plague restrictions at the docks have been removed, and captains of United States vessels may now do business in the city. This new order will hasten business at the docks, which has been stationary for some time. The plague is on the wane, but few cases now being reported.

Coke Briquettes in Germany.—Consul Warner, of Leipzig, June 17, 1901, says that a new process has been patented by which coke can be reduced to particles of about 1 millimeter in size, stirred to a paste in a concentrated solution of resinic acid, and then run into briquette molds. The briquettes are said to dry much more quickly if manganese is added to the above-mentioned adhesive solution. The Consul adds that coke has long been used by German steamboat companies, factories, gas plants and railroads, and it is expected that this new coke briquette will be consumed in much greater quantities by all of these different industries.

Wheat Crop of Russia.—Consul-General Holloway, of St. Petersburg, under date of June 19, 1901, transmits the following extracts from the Gazette of Trade and Industry, regarding Russia's wheat crop:

There are good reasons to hope that the wheat harvest of 1901 will be better than that of 1900. The spring has been favorable. The heavy rains during May, which were general in all parts of the empire, are believed to have been sufficient to secure a regular growth of the crop. As a whole, the spring wheat is more promising than the winter crop, which has suffered heavily in some provinces from the absence of snow during the winter; in others, from drought, while the greater part in the Vistula region was killed by frost. The loss, however, in the winter crop will be balanced by the amount of spring wheat sown.

Labor Commission in Northern Italy.—Under date of June 22, 1901, Consul Johnson, of Venice, reports that a labor commission consisting of eighteen members, under the presidency of the Mayor, has been established in the commune of Legnago, having for its scope: (1) To settle by amicable means disputes between owners or lessees of property and workingmen—also between employers and employes; (2) to procure work for the unemployed, within possible limits; (3) to prevent usury being practised on the workingman, and to guard him against making illegal contracts; (4) to promote the welfare of the workingman, and to foster respect for existing laws.

Exposition of Decorative Art at Turin.—The Department has received a note from the Italian Embassy, dated Washington, July 9, 1901, inclosing a letter from the Mayor of Turin to the President of the United States, expressing the hope that artists and manufacturers of the United States will take part in the International Exposition of Modern Decorative Art, to be held in Turin, in 1902, under the patronage of the King of Italy.

Exposition for Life-Saving Service in Frankfort.—Consul-General Guenther reports from Frankfort, June 17, 1901:

An exposition for accident, sanitary, and life-saving service is to be held at Frankfort, October 5 to 21. The exposition is to be exclusively scientific. Visits of workingmen will be arranged, as the chief aim will be to benefit those engaged in industrial pursuits.

Index to Advance Sheets of Consular Reports.

No. 1111. August 12.—Shortage of Wheat in France—Bicycles in Turkey—Agency for United States Goods in Toronto—* Demand for Beds in Tamatave.

No. 1112. August 13.—Economic Conditions in Japan—Gold Mines in Korea—German Exports to the United States.

No. 1113. August 14.—Copra in the Straits Settlements—Slave Trade in Egypt and Abyssinia—American Trade in Africa.

No. 1114. August 15.—*Chinese Trade in 1901—Suez Canal Traffic—* German Trade in Musical Instruments.

No. 1115. August 16.—Trading Company in Persia—An International Exposition of Agricultural Machinery—Bonded Warehouses in Mexico—New Australian Steamship Lines.

No. 1116. August 17.—*American Salesmen in Great Britain—* Proposed Exposition at Cork.

The Reports marked with an asterisk (*) will be published in the Scientific American Supplement. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

SELECTED FORMULÆ.

To Clean Marble.—

Sodium bicarbonate	2 parts.
Powdered pumice stone	1 part.
Finely powdered chalk	1 part.

Pass through a fine sieve and mix with water enough to form a paste. Rub the paste well over the marble, then wash with soap and water.

To Repair Enameled Signs.—

Copal	5 parts.
Damar	5 parts.
Venice turpentine	4 parts.

Powder the resins, mix with the turpentine and add enough alcohol to form a thick liquid. To this add finely powdered zinc white in sufficient quantity to yield a plastic mass. Coloring matter may, of course, be added if desired.

The mass after application is polished, when it has become sufficiently hard.

Patent Leather Shoe Polish.—

Yellow wax or ceresin	3 ounces.
Spermaceti	1 ounce.
Oil of turpentine	11 ounces.
Asphaltum varnish	1 ounce.
Borax	80 grains.
Frankfort black	1 ounce.
Prussian blue	150 grains.

Melt the wax, add the borax and stir until an emulsion has been formed. In another pan melt the spermaceti; add the varnish, previously mixed with the turpentine; stir well and add to the wax; lastly add the colors.

Shampoo Jelly.—

White castile soap	4 ounces.
Potassium carbonate	1 ounce.
Water	6 ounces.
Glycerin	2 ounces.
Oil of lavender flowers	5 drops.
Oil of bergamot	10 drops.

To the water add the soap, in shavings, and the potassium carbonate, and heat on a water bath until thoroughly softened; add the glycerin and oils. If necessary to reduce to proper consistence, more water may be added.

Straw Hat Varnish.—

I.

Copal	450 parts.
Sandarac	75 parts.
Venice turpentine	40 parts.
Castor oil	5 parts.
Alcohol	800 parts.

II.

Shellac	500 parts.
Sandarac	175 parts.
Venice turpentine	50 parts.
Castor oil	15 parts.
Alcohol	2,000 parts.

III.

Shellac	750 parts.
Rosin	150 parts.
Venice turpentine	150 parts.
Castor oil	20 parts.
Alcohol	2,500 parts.

Shaving Soap.—

Palm oil soap	5 pounds.
Oil of cinnamon	10 drachms.
Oil of caraway	2 drachms.
Oil of lavender	2 drachms.
Oil of thyme	1 drachm.
Oil of peppermint	45 minims.
Oil of bergamot	2½ drachms.

Melt the soap, color if desired and incorporate the oils.

Tooth Soap.—

White castile soap	225 parts.
Precipitated chalk	225 parts.
Orris root	225 parts.
Oil of peppermint	7 parts.
Oil of cloves	4 parts.

Water, a sufficient quantity.

Modeling Wax.

White wax	6 parts.
Lard	1 part.
Chalk	1 part.

Mix in a heated mortar and rub together until all lumps are broken down, and the mass is homogeneous. Additions of substances like starch, turpentine, glycerin, etc., should be avoided.

To Render Shoes Waterproof.—

I.

Ozokerite	1 part.
Castor oil	2 parts.

Lampblack, enough to color.

II.

Suet	4 parts.
Olive oil	16 parts.
Wax	1 part.
Spermaceti	1 part.

Acid-Proof Cement.—

I.

Asbestos	2 parts.
Sulphate of barium	3 parts.
Silicate of sodium	2 parts.

By mixing these ingedients a cement strong enough to resist the strongest nitric acid will be obtained.

II.

If hot acids are dealt with, the following mixture will be found to possess still more resistant powers:

Silicate of sodium (50° Baume)	2 parts.
Fine sand	1 part.
Asbestos	1 part.

Both these cements take a few hours to set. If the cement is wanted to set at once, use silicate of potassium, instead of silicate of sodium. This mixture will be instantly effective and possesses the same power of resistance as the other.—Druggists' Circular.

THE

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